WATERSHED WORK PLAN

FERRON WATERSHED

EMERY and SANPETE COUNTIES, UTAH

January 1965

Prepared under the authority of the Watershed Protection & Flood Prevention Act (Public law 566, 83rd. Congress, 68 Stat. 666) as amended.

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Prepared and Sponsored by:
San Rafael Soil Conservation District
Ferron Canal and Reservoir Company
Ferron City
Emery County Water Conservancy District
Emery County
Utah State Department of Fish and Game

with assistance by:
U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, U. S. Forest Service
U. S. Department of Agriculture, Farmers Home Administration
U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service
U. S. Department of Interior, Bureau of Land Management
State of Utah, Water and Power Board
State of Utah, Land Board
State of Utah, State Engineer
State of Utah, Department of Forestry and Fire Control
State of Utah, Cooperative Extension Services

January 1965

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WATERSHED WORK PLAN AGREEMENT

between the

955290

San Rafael Soil Conservation District
Local Organization

Ferron Canal and Reservoir Company
Local Organization

Ferron City
Local Organization

Emery County Water Conservancy District
Local Organization

Emery County
Local Organization

Utah State Department of Fish and Game
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of Utah

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Ferron Watershed, State of Utah, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration for the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Ferron Watershed, State of Utah, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed within a ten-year period.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost, $75,900.) The percentage of this cost to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Org. (Percent)	Service (Percent)	Estimated Cost (Dollars)
Multiple Purpose Structure			
Mill Site Reservoir and Recreation Facilities			
Payments of landowners for about 370 acres and cost of relocation or modification of improvements	66.2	33.8	43,000
Other land, legal fees, survey costs	100.0	0	11,000
All Other Structural Measures	100.0	0	21,900

2. The Sponsoring Local Organization will not sell or otherwise dispose of land acquired for the Mill Site Reservoir and Dam and recreation facilities for which P.L. 566 cost sharing is provided during the evaluated life of the project except to a public agency which will operate the development in accordance with operation and maintenance agreements. The lease of land for concessions for essential purposes such as lunch stands, boat rental docks, etc., will be permitted.

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of works of improvement. (Estimated cost, $100,000.)

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

	Sponsoring Local Org. (Percent)	Service (Percent)	Estimated Construction Cost (Dollars)
Multipurpose Structure and Recreation Facilities			
Mill Site Reservoir and Dam			
Irrigation Outlet	50	50	64,000
Remaining (Joint)	41.2	58.8	2,536,000
Recreation Facilities	50	50	66,800
System Improvements	50	50	286,000
Debris Basins	0	100	382,700
Fish and Wildlife Water Resource Improvements	50	50	123,200

5. The percentage of installation services cost to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Org. (Percent)	Service (Percent)	Estimated Installation Service Cost (Dollars)
Recreation Facilities at Mill Site Reservoir and Dam	50	50	16,600
All Other Structural Measures	0	100	848,400

6. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost, $75,900.)

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50% of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their lands.

8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsibile for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement does not constitute a financial document to serve as a basis for the obligation of federal funds, and financial and other assistance to be furnished by the Service and other federal agencies in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    Where there is a federal contribution to the construction cost of works of improvement, a separate agreement in connection with each construction contract will be entered into between the Service and the Sponsoring Local Organization prior to the issuance of the invitation to bid. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

14. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. Sec. 15.1-15.13), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

15. No member of or delegate to Congress or resident commissioner shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

San Rafael Soil Conservation District
Local Organization

By /S/ L. E. Thorderson

Title Chairman

Date January 18, 1965

The signing of this agreement was authorized by a resolution of the governing body of the San Rafael Soil Conservation District
Local Organization

adopted at a meeting held on January 18, 1965

/S/ Merlin G. Geary
(Secretary, Local Organization)

Date January 18, 1965

Ferron Canal and Reservoir Company
Local Organization

By /S/ Ellis Wild

Title President

Date January 18, 1965

The signing of this agreement was authorized by a resolution of the governing body of the Ferron Canal and Reservoir Company
Local Organization

adopted at a meeting held on January 14, 1965

/S/ Philip C. Nelson
(Secretary, Local Organization)

Date January 18, 1965

Ferron City
Local Organization

By /S/ Max H. Ralphs

Title Mayor

Date January 18, 1965

The signing of this agreement was authorized by a resolution of the governing body of the Ferron City Council
Local Organization

adopted at a meeting held on January 18, 1965

/S/ Carolyn Nelson
(Secretary, Local Organization)

Date January 18, 1965

Emery County Water Conservancy District
Local Organization

By /S/ Oral E. Johansen

Title Chairman

Date February 5, 1965

The signing of this agreement was authorized by a resolution of the governing body of the Emery County Water Conservancy District
Local Organization

dated February 5, 1965

/S/ Mark Humphrey
(Secretary, Local Organization)

Date February 5, 1965

Emery County
Local Organization

By /S/ Drannan Seeley

Title Board Chairman

Date February 4, 1965

The signing of this agreement was authorized by a resolution of the governing body of the Emery County Commission
Local Organization

adopted at a meeting held on February 4, 1965

/S/ Glen P. Bott
(Secretary, Local Organization)

Date February 4, 1965

Utah State Department of Fish and Game

By /S/ Harold S. Crane

Title Director

Date February 9, 1965

Soil Conservation Service
United States Department of Agriculture

By
Administrator

Date

THE WATERSHED WORK PLAN

FERRON WATERSHED

Emery and Sanpete Counties, Utah

January 1965

SUMMARY OF THE PLAN

The Ferron Watershed is located principally in Emery County with a small portion in Sanpete County. The watershed area is about 191,000 acres, all within the San Rafael Soil Conservation District.

Watershed Problems

Heavy grazing use of the watershed by livestock and big game, together with unstable soil conditions and erratic climate, have brought about depletion in plant cover and contributed to land deterioration, erosion, and the abnormal production of floodwater and sediment.

Floodwater and sediment damages to crops, irrigation canals, cropland, channels, and other improvements are widespread and make up the principal flood problems.

Because of seasonal fluctuations, the natural streamflow of Ferron Creek provides a water supply which meets about half the need for irrigation. Efforts to store water in the soil profile during high flow creates drainage, salt, erosion, and other problems. Seepage losses further deplete an inadequate water supply during periods of low flow. These conditions have contributed to low irrigation efficiencies and have limited the application of conservation treatment.

Fish and wildlife and recreation improvements within and adjacent to the watershed are inadequate. Wildlife population is limited by scarcity and poor distribution of water, food, and cover. Limited winter range is an important factor in the management of the mule deer herd.

Emery County has been designated as a distressed area under provisions of the Area Redevelopment Act. Approximately 50% of the farm families have an annual gross farm income of less than $2,500. The county had an unemployment rate of 8.6% in 1963.

Measures to be Installed

Works of improvement in this plan consist of a combination of land treatment and structural measures designed to alleviate the dominant watershed problems and contribute to redevelopment of the area. The estimated installation cost is $6,969,800, of which $3,892,100 will be from P.L. 566 funds and $3,077,700 will be from other funds.

Land Treatment Measures

Land treatment measures are needed to achieve the desired level of conservation and for effective operation of the structural measures. Conservation crop rotation, irrigation water management, farm ditch lining, and land leveling on the irrigated land will contribute to improvement of irrigation efficiencies and the conservation of soil and water resources. Renovation of grasslands will provide increases in useable forage and stabilization of soil.

Installation of contour trenches, contour furrows, gully, road, and trail stabilization, seeding, fencing, and fire prevention on the rangeland will stabilize critical sediment and flood source areas. Sagebrush spraying, pinon-juniper control, seeding, water development, fences, and improved grazing management are necessary to the success of the critical area treatment and will arrest active gully erosion, reduce summer flood runoff, and have a widespread effect in halting and reversing the trend of land deterioration.

The total installation cost of all land treatment measures is estimated to be $2,394,300. P.L. 566 funds will provide $878,300 or 37% of this cost and other funds will provide $1,516,000 or 63%. Technical assistance costs for accelerated application of land treatment measures on private and state lands will come from P.L. 566 funds.

Structural Measures

Structural measures are designed to supplement the land treatment measures in solving watershed problems.

The eight debris basins and the multiple purpose Mill Site Reservoir will prevent most of the dominant flood and sediment problems. The multiple purpose Mill Site Reservoir and the irrigation system improvements will provide for regulation and conservation of the irrigation water supply. In addition, plans for the Mill Site Reservoir provide a fish and wildlife conservation pool and recreation facilities. The Willow Lakes and Duck Fork irrigation reservoirs will be converted to fisheries. The estimated installation cost for structural measures is $4,575,500, of which $3,013,800 will be from P.L. 566 funds and $1,561,700 will be from other funds.

Non-Project Measures

The Utah State Department of Fish and Game will improve the existing Ferron irrigation reservoir to provide and maintain a fishery. The cost is estimated to be $9,500.

Benefits, Damage Reductions, and Costs

Annual benefits from structural measures used for project justification are $506,805 with annual costs of $172,975. The over-all benefit-cost ratio for the project is 2.9 to 1.0. Secondary benefits of $53,410 annually are included in benefits above. Annual redevelopment benefits of $51,215 are not used for project justification but are identified to show the impact of the project on the community.

The Mill Site Reservoir and debris basins will have flood prevention benefits of $46,780 annually. Annual flood prevention cost is $36,570. Present flood damages will be reduced by 90%. The debris basins will have $3,440 in annual irrigation benefits. The Mill Site Reservoir and irrigation system improvements will have $327,380 per year in irrigation benefits compared to an annual cost of $103,985. The fish and wildlife conservation pool and the recreation facilities in the Mill Site Reservoir will have annual benefits of $47,745 compared to an annual cost of $23,505. The Duck Fork and Willow Lakes fisheries will have annual benefits of $28,050 per year compared to an annual cost of $8,915.

Project Installation and Financing

Sponsoring organizations will acquire necessary land and water rights, execute agreements with owners of private lands for installation of the land treatment measures, and provide the non-federal share of the installation cost for project measures and non-project costs. Sponsoring organizations will contract for construction of the structural measures in the plan. Funds for payment of the non-federal share of the installation costs, including repayment of loans for this purpose, will be provided through assessments of irrigation company stock and contractual arrangement by the sponsors and water users. Legal authority for assessment and contractual arrangement of these local organizations is adequate to meet financial responsibilities.

Operation, Maintenance, and Replacement

Annual operation, maintenance, and replacement costs for structural measures are estimated to be $23,080. Structural measures will be operated, maintained, and replaced by the local sponsors. Land treatment on private and state land will be operated and maintained by private land owners and operators. Land treatment measures on federal land will be operated and maintained by the land administering agencies.

DESCRIPTION OF THE WATERSHED

The Ferron Watershed is located in central Utah, in western Emery and eastern Sanpete counties. The watershed area, approximately 30 miles long and 10 miles wide, containing 191,000 acres, is all within the San Rafael Soil Conservation District.

The farm owners and operators live mainly in the towns within and adjacent to the watershed. Approximately 275 people live outside of town limits. The towns of Ferron, Clawson, and Molen, with populations of 386, 100, and 40 respectively, are in the watershed. Orangeville, with a population of 571, is located just north of the watershed. Castle Dale, the County Seat of Emery County with a population of 617, is located three miles northeast of the watershed. There are 123 farm and ranch units in the watershed.

Ferron and Rock Canyon drainages, with 250 and 50 square miles of drainage area respectively, make up the watershed. It is bounded on the north by the Cottonwood Creek drainage, on the south by Muddy Creek and Molen Seep drainages, on the west by the Wasatch Plateau Summit, and on the east by the San Rafael River.

Elevations range from over 11,000 feet on the Wasatch Summit to 5,600 feet near the San Rafael River. A great erosion escarpment separates the mountainous upper watershed from the lower, which consists of a broad undulating valley. Rough topography, dissected frequently by small drainages, predominates in the mountains. Gentle to severe undulations separated by meander patterns and flood plains of drainages with knolls and ridges throughout characterize the topography of the valley land.

Ferron Creek heads in the Wasatch Plateau at an elevation of over 11,000 feet. This perennial stream flows southeast for approximately 20 miles to the town of Ferron. From Ferron, it turns slightly to the northeast and flows through undulating valley land for about 12 miles to the San Rafael River. Rock Canyon Creek heads on the North Horn Mountain at an elevation of over 9,500 feet. The channel of this intermittent stream flows on a course parallel to Ferron Creek. However, it is about 15 miles shorter.

The great erosion escarpment is drained by many small streams ranging in length from 1-1/2 to 7 miles with drainage areas of from 1/2 to 12 square miles. These small drainages are tributary to Ferron and Rock Canyon creeks and are the source of summer floods which damage the irrigated area.

Ferron Creek, with a median annual yield of 43,000 acre feet, is the principal source of water supply. This water is mostly from snowmelt runoff. Streamflow begins to rise in late April, reaches a peak in late May or early June, and diminishes rapidly to a base by the middle of July. As much as 50% of the yield of the drainage comes in a 15 to 30-day period in May and June.

Rock Canyon Creek has an erratic yield and is not dependable as a source of irrigation water. Ferron Creek and Rock Canyon Creek produce both snowmelt and summer floods.

Principal uses of water include irrigation, culinary, municipal, and livestock.

The Ferron Canal and Reservoir Company serves all of the irrigated land. The company has three small reservoirs located high in the upper watershed. They have a combined capacity of 2,100 acre feet and have been used to store runoff during the peak snowmelt period. Stored water has been released to increase base flow of the Ferron Creek after snowmelt runoff has diminished. The company has also constructed several "seepage" reservoirs which prolong the base flow of the streams. Water is diverted from Ferron Creek at the mouth of Ferron Creek Canyon and at several other points downstream into earth canals to serve the irrigated area. There are approximately 28 miles of main distribution canals in the watershed.

Mean monthly temperatures range from 20^{o} in winter to 70^{o} in summer. Average frost-free period is 158 days. The average growing season is 200 days, April 5 to October 22. Precipitation at higher elevations comes mainly in the form of snow. The valley area receives about 8 inches of precipitation with about one-half coming during the growing season. Precipitation increases with elevation to about 40 inches on the Wasatch Summit. Violent summer thunderstorms occur along the escarpment and upper watershed. Runoff from these storms causes considerable erosion and produces the major floods on the small drainages and Rock Canyon Creek.

Mule deer is the most important game animal. Elk are present in limited numbers. Principal upland game bird species are pheasant, chuckar, partridge, dove, and sage and forest grouse. Waterfowl use of the area is light because of habitat limitations. Rainbow trout, planted by the Utah State Department of Fish and Game, are present in the uppermost reaches of Ferron Creek and in the small reservoirs. An occasional cutthroat trout is taken by the angler.

About 28,000 acres of private land is located mainly in the valley portion. Approximately 9,700 acres of state land is interspersed throughout the watershed. Federal lands total about 153,300 acres, of which 41,300 acres are administered by the Bureau of Land Management and are located mainly below the great erosion escarpment in the undulating valley. Approximately 112,000 acres are within the Manti-LaSal National Forest and occupies the upper portion of the watershed.

The irrigated land, 11,335 acres, is made up of the deeper soils located along the streams on fans, and on terraces throughout the valley. Approximately 8,615 acres are in irrigated crops such as alfalfa, small grain, corn, and fruit. Approximately 2,720 acres are in pasture with varying degrees of wetness and slight to moderate amounts of saline salts. A part of the irrigated land is in small isolated parcels because of the steep sided gullies and irregular topography which dissects the landscape.

The remaining portion of the valley is made up of rangeland. Soils are derived from shales, have a low water intake rate, and are subject to accelerated erosion. Plant cover is limited to sparse, semi-desert type vegetation primarily because of moisture and soil deficiencies. This has been further aggravated by past grazing abuse.

The upper watershed is important for range, recreation, and watershed values. The soils are generally deep to moderately deep, and have medium to fine textures. A band of heavier clay soil with nearly impervious strata at shallow depths occurs near the top of the watershed. Both the topsoil and subsoil in these areas are highly erodable. Many of the slopes in the head of the Ferron drainages are results of a series of landslides representing varying ages and degrees of stability. Gullies of recent origin exist here and have cut to depths of 10 feet or more. Sheet erosion from overland flow is widespread and has removed much of the valuable topsoil.

A combination of unstable soils and depletion of vegetation by big game and livestock grazing has contributed to the severe erosion problem.

Soils

The soils in the valley are alluvial and residual deposits derived mainly from sandstones, limestones, shales, and siltstones. The materials occur as floodplain, fan, and terrace deposits interspersed with bedrock outcrops in the form of ridges and knolls. Soil materials on the terraces are gravelly, 20 to 48 inches deep, and are underlain by sandstone and shale bedrock. Soils on the alluvial fans are sandy or gravelly and generally deep. The flood plain and residual soils are shallow to deep and have a loam or silty clay loam texture. Some of the floodplain soils are wet and are slightly to severely affected by salts. Slopes of the irrigated soils range from 0 to 6%.

Rangeland soils are of two types. The upper valley and lower foothill soils are shallow, predominantly fine grained, and underlain by mancos shale bedrock. Slopes range from 0 to 30%. The intermediate and high mountain rangeland soils have developed on alluvial and colluvial slopes ranging from 2 to 70%. These soils are deep to moderately deep and generally have medium to fine textures. Bedrock outcrops of sandstone and limestone are common; and shallow, gravelly soils occur on the steeper slopes.

Economic Data

A 1960 population of 5,546 persons marked a decline of 12% in the population of Emery County since 1950. During that period, the population of the watershed decreased by 15%. This decline has been largely concentrated in the communities of Ferron, Clawson, and Molen, with 1960 populations of 386, 100, and 40 respectively.

People of the watershed live mostly in the communities and operate their farms in the adjacent irrigated areas, which is an operation pattern typical of most of Utah's agriculture. About 31% of the 123 farm operators work off the farms, while approximately 15% derive the greater part of their income from off-farm sources. Employment is provided by nearby coal companies and state, county, and federal activities within the area.

A typical operating unit consists of about 200 acres including about 70 acres of irrigated cropland, 20 acres of irrigated permanent pasture, and 110 acres of rangeland. Most of the crops grown are utilized on the farms in the production of beef, mutton, wool, and milk. The chief livestock enterprise is beef production which is largely sold in the Utah and Colorado markets. The dairy producers truck fluid and commercial milk to the Salt Lake City market.

There are 44 beef cattle operators living within the area who hold grazing permits on federal lands. In addition, there are 23 cattle permittees and 56 sheep permittees who graze their livestock within the watershed area, but who live outside its boundaries. Summer grazing is provided on the National Forest or on private pasture and meadow lands. Some stock are grazed part of the winter on public lands. Livestock operators feed supplemental amounts of hay and concentrates during part or all of the winter.

Although the principal production units are a cow-calf type of operation, the people have initiated and expanded an active feeding and herd improvement program. The Emery County Livestock Show is an outgrowth of this activity which annually attracts beef producers and buyers from Utah and adjacent states.

Fruit production is of secondary importance. A few farms near the mouth of Ferron Creek have small acreages in orchards. Principal fruits are peaches, pears, and apples, with lesser amounts of apricots, cherries, and plums. Climatic factors are favorable for an expansion of this enterprise. The eastern Utah area provides an excellent market for quality fruit. A stable water supply is an important factor in fruit production.

There are approximately 27,000 acres of timber type. Of this acreage, about 9,000 are commercial aspen and 11,000 acres are commercial conifer, with the remaining 7,000 acres in noncommercial timber types. Several small sawmills rely heavily on this timber with most of their products being used locally. Principal conifer species are spruce, Alpine fir, and Douglas fir.

A network of state, county, National Forest, and public land roads provide adequate access to all parts of the project area. However, the extreme upper portion of the watershed is normally accessible only from June to October. Utah Highway 10 which connects with U. S. Highways 89, 50, and 6 passes through the towns of Ferron and Clawson. This is an oiled highway which is open during the entire year. Interstate Highway U. S. 70, now under construction, will pass 30 miles to the south of Ferron and will connect with Utah-10. The nearest railhead is 42 miles to the north at Price, Utah.

Recreation facilities developed to date have largely been designed for local use. Water resource improvements for fishing are inadequate. However, picnicking, camping, and fishing use are on the increase, particularly by non-local state and out-of-state people. The area has a high potential for fishing and recreation use. The present level of these activities benefit only a few local businesses.

The following table shows the distribution of farms on the basis of census economic classes.

Farms by Economic Classes

Commercial Farms	Annual Value of Farm Products Sold	Present No. Farms	Percent of Farms in Class
Class 1	Over $40,000		
Class 2	$20,000 to 39,999	2	2
Class 3	$10,000 to 19,999	11	9
Class 4	$ 5,000 to 9,999	32	26
Class 5	$ 2,500 to 4,999	16	13
Class 6	$ 50 to 2,499	16	13
Other Farms			
Part Time and Retirement	$ 50 to 2,499	45	37
Abnormal		—	—
		123	100.0

WATERSHED PROBLEMS

The dominant problem is damage from sediment and floodwater to the farm lands; erosion; forage and land deterioration in the upper watershed; and the seasonal pattern of streamflow, providing an unfavorable irrigation water supply. These conditions have prevented the adoption of efficient crop rotation and management practices on the farms. Water distribution difficulties and moderate to severe seepage losses in many areas have tended to limit improvements of irrigation distribution systems.

Opportunity for good fishing and recreation activities are not adequate to meet the needs.

Flood and Erosion Problems

All drainages have produced floods of varying magnitude from summer rainstorms and snowmelt. The location of each drainage with respect to improved areas and the capacity of the channel systems are important determinants in the amount of flood and sediment damage suffered. Most of the flood damages are to crop and pasture land, and to irrigation facilities and property.

Heavy grazing, beginning about 1870 and continuing until about 1910, generally depleted the forage resources of the watershed and caused accelerated erosion and deterioration of the inherently unstable soils. Overuse by livestock and big game for a number of years after 1910 has continued the acceleration of erosion and runoff. Grazing adjustments and improved management practices have slowed down erosion rates and reduced flood runoff to a limited degree. Improved management is the only feasible treatment over much of the watershed and will bring about slow recovery. Critical area treatment where adaptable will produce immediate reductions in erosion and runoff rates.

Summer storms originating in drainages above the proposed Mill Site Reservoir cause considerable erosion and produce small floods which cut channels of the small drainages, damage roads and trails, and deposit, silt, mud, and debris in the larger flatter channels. These floods partially dissipate before reaching the farming area. Moderate amounts of silt and debris are deposited in irrigation systems and in downstream channels. Sediment, mud, and debris deposited in upstream channels are moved out by snowmelt flow the following spring and carried through the distribution systems and onto the farmlands.

Especially intense summer storms which affect a large area sometimes produce floods which deliver peak discharges undiminished, together with sediment and debris, to the farming area. These infrequent floods deposit unusually large amounts of sediment and debris in the irrigation distribution systems, and on the farmlands through the distribution systems with alternate filling and cutting of the downstream Ferron Creek channel. The 1947 flood which resulted in the loss of two lives caused silting of ditches, cutting of farmlands along the channel, washed away bridges and headgates, and inundated the culinary water works of Ferron City. It also damaged roads, trails, and recreation facilities in the upper watershed. The U. S. Geological Survey streamgage was rendered inoperable by this flood. Therefore, no estimate of peak discharge is available.

The summer flood of August 27, 1952, with an estimated peak discharge of 4,180 cubic feet per second, was the largest in the memory of local residents.

Snowmelt runoff from Ferron Creek comes mainly in the months of May and June with as much as 50% of the annual yield of the drainages coming in a 15 to 30 day period. Peak flows often reach flood magnitudes. The rate of flow during the peak flow period, together with the duration of the flow, is sufficient to remove the silt and sediment deposited in the upstream channels by small summer storms the preceding year and to do considerable cutting in the downstream improved areas.

The short drainages heading in the great erosion escarpment west of Ferron produce from one to three floods per year. One drainage may produce as many as three floods in any given year or conversely may not produce a flood for several years. Floods from these small drainages damage crops, cropland, and fixed improvements such as canals, ditches, fences, roads, town lots, and corrals. These floods transport considerable amounts of sterile sediment because of the extensive expanse of saline siltstone and sandstone in the drainages. It is not unusual for the main distribution canal to be filled with this fine sediment for as much as half a mile from the point of intersection with the drainage. Canals are often broken as well as filled and must be cleaned and repaired before delivery of irrigation water can be made.

Many of the floods occur during the hay-grain harvesting period. Serious damages to the partially harvested crops occur and this damage carries over to the next crop because the preceding crop and flood debris cannot be removed immediately. Much of the irrigated land has been damaged by deposition and spreading of unfertile, fine textured sediment which lowers soil fertility, reduces water intake rate, and causes surface irregularity. Drainage problems are increased because drains and natural water courses become partially filled with sediment.

Irrigation Problems

The natural streamflow of Ferron Creek, which is the principal source of irrigation water supply, is at a rate in excess of irrigation requirements during May and June and diminishes to a rate below irrigation requirements the middle of July. The flow of the stream is far below irrigation requirements for the remainder of the irrigation season. The flow of the stream in March and early April is not sufficient for pre-plowing and pre-planting irrigations.

The unfavorable distribution of the water supply has not been conducive to the construction of efficient distribution systems, control structures or measuring devices, the establishment of key conservation practices, or the adoption of efficient water management methods. High operations losses in delivery of water and low on-farm irrigation efficiencies result. The natural tendency of the farmer to store as much water as possible in the soil while water is available has contributed to reduced yields, erosion problems in disposal of tailwater, and drainage and salt problems in the lower lying fields.

Seepage losses in canals range from low to moderate. These losses contribute to the drainage problems during periods of high flow and further deplete the water supply during periods of low flow.

The flood and sediment problems detailed in a preceding discussion have compounded the irrigation problems and have further limited the operator's economic ability to install improvements and apply advanced farm technology.

Grazing and Related Problems

Ranchers have made efforts in recent years to improve their range by practicing proper range use and establishing such practices as brush control and range seeding. Soil and precipitation conditions at higher elevations favor successful establishment of land treatment measures. These areas are either in federal ownership or federal management. Private lands are located at lower elevations where soil conditions and precipitation limit success of land treatment. Improvements in these areas will be brought about mainly by management.

The federal land administering agencies have recently made some adjustments in grazing permitted on portions of the federal rangeland as a step toward bringing grazing in balance with forage production capacity. Treatment measures outlined in the plan will restore some of the potential capacity for forage production incidental to the stabilization of critical areas and ultimately some of the reductions may be restored. Improved conditions on the irrigated land which will result in an increase in the production of pasture and forage crops will fill part of the need for substitute forage. Other operators will find suitable rangelands outside the area until the range recovers enough for reinstatement of part of the grazing reductions.

Fish and Wildlife and Recreation Problems

The infrequency of bodies of water within 50 miles of Ferron town limits the opportunity for fishing and associated recreation. Scofield Reservoir near the head of the Price River, approximately 75 miles by road north of the watershed, and Fish Lake in the Fish Lake Mountains, about 70 miles to the south, are the only existing large bodies of water which support water based recreation other than fishing in this section of the state. The Cleveland, Millers Flat, and Huntington irrigation reservoirs, approximately 30 miles to the north, and the Ferron Reservoir within the watershed, support fisheries for a part of the year. The storage volumes of these reservoirs are needed desperately for irrigation by mid-July leaving a small shallow pool. The Joe's Valley Project of the Bureau of Reclamation on the Cottonwood drainage will provide for fishing and associated recreation at the Joe's Valley Reservoir and Dam. These reservoirs are located at higher elevations and are accessible or useable for only a part of the year because of snow packed roads and frozen water surfaces.

Upper elevations of this and adjacent watersheds are dotted with small natural lakes in pot holes resulting from landslides and glacial action. Seldom do these lakes have sufficient depth, volume, or inflow to carry fish through the winter or to support appreciable numbers of fish.

The summer flood of August 27, 1952, with an estimated peak discharge of 4,180 cubic feet per second, was the largest in the memory of local residents.

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Fishery resources in the watershed are inadequate to meet current demands. Trout planted by the Utah State Department of Fish and Game in the better natural lakes and irrigation reservoirs quickly disappear in the creels of early season fishermen. Other recreation uses, including camping and hunting are moderately heavy.

The limited amount of winter range for mule deer, inadequate amounts and poor distribution of water and scarcity of suitable food and cover for upland game birds all contribute to mortality and limit game population.

Improved fisheries and recreation improvements are needed to provide a rounded recreation opportunity for users, to increase the frequency of their visits, and prolong their stay. A body of water large enough to meet the fishing and associated recreation needs which will be accessible and open most of the year is needed to improve the economic opportunity of the community.

Economic Problems

Mining and livestock agriculture are the main sources of income of Emery County and the watershed. To earn a livelihood, many farm operators depend on part-time employment in the coal mines, located outside the watershed, and on small scale farming. Part-time employment in the mines is possible because the peak production period for coal comes during the winter lull in farming activity.

Although coal mining is still important, there has been a 35% reduction in coal production and a 40% decrease in wage disbursement for coal mining since 1956. Over the same period, employment in non-agricultural and in the agricultural sectors of the economy has decreased as shown below.

Employment - Emery County

	1957	1958	1959	1960	1961	1962	1963
Non-agriculture	1490	1300	1238	1260	1187	1170	1140
Agriculture	656	639	622	607	572	547	522
Total	2146	1939	1860	1867	1759	1717	1662

Although declines in coal production are responsible for a significant proportion of the reduced employment, technological improvements which have increased labor efficiency in mining and farming have added to the problem.

While the level of employment in mining and agriculture has declined, personal income from farming in Emery County has increased by 62% during the 1957-1962 period. This change in farm income has been brought about in part by consolidation of farms into larger and more efficient units. There has been a decrease of 13% in small farms during the 1954-1959 period and a corresponding increase in family size farms. By incorporating small and relatively unproductive units into larger and more efficiently operated family farms, production and income has been increased, in spite of water shortages and other limitations.

Other agricultural changes reflect the impact of mining decline. The percentage of farmers working off their farms has reduced from 78% in 1954 to 31% in 1959. Farm operation and labor efficiency has risen from 71% in 1954 to 80% in 1959, reflecting in part the effect of absorbing small farms into the larger and more efficient farming units. Thus, it can be said that in some ways the stresses set up by the decline in mining activity have accelerated desirable trends in the local agriculture. These trends will probably continue through the next 5 or 6 years, but at a slower rate.

On the other hand, the creation of efficient family farm units through consolidation and reorganization is sharply limited by the deficient water supply and by the need and desire for small part-time farming units. Part-time mining and farming will continue to provide a full livelihood to many persons, and small retirement farms are a desirable aspect of the local social and economic structure. Thus, the opportunity for improvement through consolidation will diminish in future years and the dominant remaining deterrent to improvement will be water supply limitations.

In consideration of the uncertain outlook for mining and industry, it would appear that the most practical solution toward an acceleration of the current stagnant economy of the area lies in achieving more efficient use of the underdeveloped land, water, and recreation resources in the watershed. The plan outlined hereinafter is designed to attain this objective to the most practical degree.

PROJECTS OF OTHER AGENCIES

There are no other water resource development projects, existing or contemplated, within the watershed. The Emery Project of the Bureau of Reclamation will provide supplemental water for the irrigated area immediately to the north of the watershed. There is no connection between the service areas of these projects. Jointly, they will both contribute to the over-all development of Emery County and Utah.

Existing soil and water conservation programs of local, state, and federal agencies will be complemented and materially assisted by treatment measures to be installed under this plan.

BASIS FOR PROJECT FORMULATION

This plan is a coordinated approach for treatment of all watershed lands.

Measures included in this plan were formulated after watershed problems were studied thoroughly. Objectives of the local people with regard to intensity of treatment and level of protection and experience in solution of similar problems served to guide in selection of the measures.

The overriding objective of the sponsors of this project is to make maximum practical use of available resources consistent with the needs and problems of the area, to increase and stabilize net farm income, and contribute to the economic stability of the watershed and surrounding communities.

Specific objectives of the sponsors are to:

1. Effect significant reductions in damage from sediment and floodwater.

2. Stabilize critical flood and sediment source areas and protect the watershed lands from erosion and summer flood runoff and maintain the productive capacity of the soil.

3. Regulate the yield of Ferron Creek by storage to meet, as nearly as practical, monthly and seasonal requirements for irrigation.

4. Improve and reorganize the irrigation distribution system to reduce seepage and operational losses, and operation and maintenance cost.

5. Develop the water resources to meet demands for fish and wildlife, recreation, and other uses.

Land Treatment Measures

The combination of land treatment measures scheduled for installation on private and state lands reflects evaluation of land capabilities, land and water use, cropping patterns and practices, and physical and economic factors which contribute to optimum efficiency in the utilization of watershed resources in the operation of prevailing types of agricultural enterprises. The combination and amounts of measures selected will, when applied, ensure the levels of production and the benefits needed to justify the average annual costs of installing and operating the structural measures.

The land treatment measures to be installed on federal land are designed to meet the treatment needs of critical flood and sediment source areas and to contribute to the creation of conditions which will promote optimum use of the land, water, and recreation resources in the upper watershed. The estimate of kinds and amounts of treatment needed is based on analysis of conditions in specific problem areas and evaluations of the effectiveness of alternative measures in alleviating existing problems.

Measures selected are feasible and will stabilize critical areas, reduce sediment production and summer flood runoff, prevent land deterioration, and contribute to increased forage production and recreational use.

Structural Measures

Structural measures were selected from alternatives for both the desired physical effects and benefits. Structural measures included the multiple purpose Mill Site Reservoir Dam and recreation facilities, eight debris basins, improvement to the irrigation distribution systems, and two fish and wildlife water resource improvements.

Mill Site Reservoir and Dam

The need to regulate the irrigation water supply through storage and reduce sediment and flood damages from Ferron Creek is the principal basis for the Mill Site Reservoir. Fish and wildlife capacity and recreation facilities included with this reservoir are based upon present and expected demand and the need to strengthen the economy of the area.

The capacity reserved for sediment accumulation is based on expected sediment rates over the next 100 years. The capacity to be maintained for fish and wildlife development was selected to provide a good fishery and optimum recreation use in consideration of other demands for water. The irrigation capacity selected was based upon the costs and benefits for providing increments of storage for irrigation.

The irrigation capacity is sufficient to store summer floods and reduce the duration and peak discharge of snowmelt floods to a point where downstream channels will accommodate them.

Alternate proposals considered included four dam sites in the vicinity of the Mill Site, off-channel storage sites and diversion works, and a number of debris basins and storage sites in the upstream drainages.

The Mill Site Reservoir and Dam are the most feasible, economically and physically, and will best meet the objectives of the local sponsors.

Recreation Facilities: Recreation facilities at the Mill Site Reservoir were selected to meet anticipated need in the immediate future. The sponsors recognize that additional facilities will be required as use increases in years to come. They have indicated their intention to provide additional facilities when needed.

Debris Basins

Sediment and floodwater, which originates in the short, steep drainages heading in the great erosion escarpment and damages irrigation canals, cropland, and cultural improvements, are the basis for including the eight debris basins in the work plan. Because of aspect, topography, local relief, and the type of flood producing storms, not all of the short drainages have a significant flood history. Some drainages have deep channels which convey flows through the improved areas.

Interviews with local people, discussions in public meetings, and a thorough reconnaissance of the damage and flood source areas was the basis for selecting the drainages to be controlled by structural measures. Alternative capacities of debris basins which would provide protection from the 25, 50, and 100-year frequency floods immediately downstream from the structure were evaluated, as were proposals for long-term storage of sediment as contrasted to periodic removal of sediment depositions. Capacity to store 100 years of sediment accumulation and to contain the routed 100-year frequency flood was determined to be the most economical in consideration of the benefits received.

Alternatives considered include debris basins at other sites on the drainages and a combination of canal overshots with downstream channel work. Other debris basin sites were eliminated due to high costs or site limitations. Overshots in channels were eliminated because of high costs and because these structures would tend to only shift the problem to another location.

System Improvements

Irrigation structural measures are based on conservation plans developed by the irrigation company and the Soil Conservation District. These improvements were selected to reduce seepage loss and minimize operations problems. Both size and location of present facilities were adjusted, where needed, in view of the stabilized water supply to be provided from the Mill Site Reservoir. Treatment measures to reduce seepage losses include relocation and lining of individual canals and canal sections where seepage loss measurements show the need. Installation of these structures will facilitate the management of water. Where necessary, the system was reorganized to deliver water most effectively under the project conditions.

The kinds and amounts of irrigation system improvement structural measures included herein were selected after evaluation and discussion of each proposal including the amounts of water to be saved, reduction in operation and maintenance costs, installation costs and benefits, cost sharing, and the ability of the company to finance and repay their share of the installation cost.

Fish and Wildlife Water Resource Improvements

The need for dependable fishery resources in the upper watershed is the basis for changing the irrigation reservoirs to fishery use. This need is supported by the use record of the small irrigation reservoirs and natural pot holes in the landslide topography. Because of drawdown of the irrigation reservoirs, shallow depths in the pot holes, associated winter kill, and high restocking cost, the existing reservoirs and lakes do not provide a satisfactory fishery resource.

Fifteen suitable alternatives to meet this need, including existing reservoirs, natural lakes, and reservoir sites, were examined from the benefit-cost standpoint. The sites selected are the most economical and will automatically regulate the 100-year frequency snowmelt runoff and summer floods from the contributing watersheds and give varying degrees of flood protection to stream channels, roads, and other values, in addition to providing a fishery resource.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Land treatment measures included in the plan are in accord with the long-range plans of the San Rafael Soil Conservation District and the federal agencies responsible for the administration of federal lands. They are a key unit in the plan since the achievement of maximum stability in erosion and runoff in the upper watershed is a basic requirement to the efficient functioning of the structural measures and is an essential factor in the

success of the project. As groups of interdependent measures, they are primarily designed to correct the dominant on-site problems of critical flood and sediment source areas. An added and important associated effect of these measures is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control and irrigation. They will also contribute to the improvement and preservation of upper watershed resources and to their optimum utilization.

Land treatment on the rangeland and upper watershed consists of (1) measures designed to stabilize critical areas and (2) those required to ensure their success and for efficient management of the area. The critical area treatment consists of contour furrowing, plowing, pinon-juniper eradication, roadside erosion control, gully plugs, and seeding. Road improvement, sagebrush spraying, seeding, livestock water developments, and intensified management are needed to ensure successful functioning of the critical area treatment and enable proper use of the rangeland. The primary effect of the combined treatment will be to reduce summer flood peaks, arrest active gully erosion, and reverse the trend in widespread deterioration of the land and plant cover. An important effect will be the increased production of useable forage for livestock and big game. The watering development for livestock and wildlife will enable better distribution of livestock and big game and increase the range of upland game birds.

Land treatment for the irrigated land will include conservation cropping systems, improved irrigation water management, land leveling, structures for water control, on-farm ditch lining, and wildlife plantings. The primary effect of the combined treatment will be an improvement in farm irrigation efficiency. Improved irrigation water management is an important project objective because of its contribution toward improved on-farm irrigation efficiencies. This practice will be given special emphasis through the going and accelerated programs of the District. These measures will also enable more efficient use of water to be developed by structural measures. Reduced labor inputs and improved soil fertility are among additional important secondary effects.

Installation cost for land treatment measures is estimated to be $2,394,300, of which $878,300 or 37% will be from P.L. 566 funds and $1,516,000 or 63% will be from other funds.

The cost of critical area treatment on the Manti-LaSal National Forest, estimated to be $728,400, will be from P.L. 566 funds. Other land treatment costs on the National Forest, estimated to be $1,201,400, will be from regular funds of the Forest Service. The cost of critical area treatment on federal lands administered by the Bureau of Land Management, estimated to be $113,300, will come from P.L. 566 funds. Other land treatment cost on federal lands administered by the Bureau of Land Management, estimated to be $49,600, will come from regular funds of the Bureau. Application cost, estimated to be $246,200, for land treatment measures on private and state land, will be from other funds. Of this cost, $1,000 for wildlife planting will be from Utah State Department of Fish and Game funds. The remaining cost, $245,200, will be furnished by private owners and operators with cost sharing assistance available under other programs at the time of installation. Only the cost of additional technical assistance for accelerating the installation of land treatment measures on private and state lands will come from P.L. 566 funds.

Structural Measures

Structural measures to be installed will supplement the land treatment program in alleviating the principal flood problems of the watershed and in making more efficient use of water supplies. They will solve the outstanding flood problems, provide for an increased water supply for irrigation, and will create much needed water resources for fish and wildlife and recreation opportunity. They will contribute to the economic well being of the community--both agricultural and urban. See Tables 1 and 2 for estimated cost distribution for all structural measures. See the Project Map for location.

The Mill Site Reservoir, Dam, and Recreation Facilities

Reservoir and Dam: This site is located on Ferron Creek about 3 miles west of Ferron, Utah, at the mouth of the canyon. This development provides for irrigation storage regulation, flood prevention, a fish conservation pool, and recreation facilities. The Ferron Canal and Reservoir Company will provide for unrestricted access to and use of the fishery pool and recreation facilities by the general public. The existing road will be relocated to provide access to the reservoir pool and recreation facilities. The irrigation company will acquire title to private and non-federal public lands, and easements and rights-of-way for federal lands for road relocation, recreation facilities, the reservoir pool, and a perimeter strip around the reservoir pool at least two vertical feet above the crest of the emergency spillway. No group or private developments will be allowed which would restrict public access to or use of the recreation facilities or the perimeter of the reservoir at any stage.

The recreation facilities will be made available to the general public on a first come, first serve basis after payment of a use fee. No charges will be made for access to the reservoir.

The total reservoir capacity of 18,000 acre feet will provide 2,000 acre feet for fish conservation, 5,800 acre feet for the expected 100-year sediment accumulation, and 10,200 acre feet for irrigation storage and regulation. Location is shown on Figure 1. Principal features are shown on Figures 3 and 4.

Because of the critical need for irrigation water common to all of Utah and to the project area especially, the initial permanent pool will be set at the 2,500 acre foot level. This will allow for the desired 2,000 acre feet for fishery storage plus the expected sediment accumulation in that pool during the first 10 years of operation. Thereafter, the level of the irrigation outlet will be raised every 10 years to provide the sediment capacity to be required during the next 10 years, approximately 470 acre feet. The remaining capacity of the reservoir will be used for irrigation storage and regulation. The initial capacity for irrigation will be 15,500 acre feet and the final capacity for irrigation at the end of the 100-year period will be 10,200 acre feet, giving an average of 12,850 acre feet.

The surface area of the initial fishery pool of 2,500 acre feet will be 127 acres. At the end of the 100-year period, it will be 236 acres. Surface area of the full reservoir, including the irrigation supply, is 420 acres. Vertical drawdown due to irrigation releases could amount to 58 feet initially decreasing to 34 feet in 100 years. However, the full reservoir area of 420 acres will be available for fishing and recreation purposes early in the season and most of this will be available for a substantial part of the season. Heavy withdrawals of irrigation water will not begin until the latter part of July. The surface area of the reservoir will, in an average year, be approximately 400 acres about July 15, and the minimum pool elevation will not be reached until about September 1.

The reservoir dam will be of zoned earth, 114 feet in height, with a top width of 42 feet, 3:1 slopes downstream, 3-1/2:1 slopes upstream, with a berm of 20 feet. The upstream face of the dam will be protected by riprap. Rock and coarse fill material will be routed to the downstream shell zone, and will provide protection on the downstream slope. Vegetation will not be required for protection. A partial cutoff, a rock and gravel filter drain with pipe, and a relatively impervious blanket three feet in thickness extending some 600 feet upstream from the dam will contribute to stability of the earth fill and limit seepage flow from the reservoir. The emergency spillway will be in rock cut some 1,000 feet in length and terminate in a natural plunge pool. The inlet crest of the spillway will be of reinforced concrete. A deflector bucket will be installed at the outlet end of the spillway and will discharge into the natural plunge pool. Spillway flow will return to Ferron Creek by way of an exit channel excavated to rock.

The irrigation outlet will consist of a ported riser, an outlet conduit with double control gates and dry man well-access shaft, and an inlet conduit with gate for emergency drainage of the reservoir. The riser, the inlet and outlet conduit, and the dry man well-access shaft will be placed on competent bedrock.

Creation of the reservoir will necessitate the relocation of approximately 3.0 miles of road. The County road is the main access route to the upper watershed.

The total estimated installation cost is $3,352,000. Of this total, $2,186,400 will be from P.L. 566 funds and $1,165,600 from other funds. The Utah State Department of Fish and Game will provide the non-federal share of construction cost allocated to fish and wildlife, estimated to be $140,800. The Ferron Canal and Reservoir Company will provide the remaining non-federal share of the cost.

Recreation Facilities: The recreation facilities will be located as shown on Figure 5 above the maximum water level and under the new road leading to the upper watershed.

The recreation facilities consist of 19 camping units, one picnic shelter, two toilet units, a parking lot, two boat ramps, access roads, culinary and irrigation water systems, electric power and outlets, and landscaping. Two boat ramps will be installed because of the topography of the site and fluctuations in water surface. One ramp, 400 feet in length, will be adjacent to the

parking lot and the other, 200 feet in length, will be located at the end of a road to low water. The boat ramps will be 70 feet wide, surfaced with 4-inch compacted gravel, and a 15-foot travelway of concrete logs on the west side to provide traction. Gravelly slopes nearby are suitable to beach boats.

Each camping unit will consist of a covered picnic table with screen fence and a ring type cooking unit. The stub road will provide parking space for trailers or campers and automobiles. The picnic table will be of wood. The cover will be of wood frame with a corrugated plastic top. See Figure 5 for details. The flush type toilets will be equipped with 4 seats each, 2 basins, a septic tank, and drainage field. The housing will be of wood frame with corrugated steel roof and concrete floors. The picnic shelter, 24 feet by 12 feet, will consist of a 4-inch concrete slab, with tables, a cover, an upright cooking facility, and a campfire ring. The concrete slab will be reinforced with 6 x 6 No. 10 mesh. Footings 4 inches by 1 foot will be poured as a part of the slab. The tables and seats will be of wood. The cover will be of corrugated plastic on wood frame. Barriers, consisting alternately of rustic log posts and rails and huge rocks, will be placed to insure best use of the facilities and to protect the aesthetic value of the development. The water system for both culinary and irrigation purposes will take out of the city water line just below the dam. The system will consist of a 42 gallon per minute pump, a 5 horsepower motor, 4,000 feet of 2-inch supply line, a 500 gallon storage tank, 3,000 feet of 2-inch distribution lines to toilets, faucets, and irrigation outlets. Hydrants will be located conveniently throughout the area for culinary water. Five acres will be irrigated by sprinklet methods.

The electric power lines will be brought in from existing lines below the dam. A 20 kilowatt transformer will be installed at the entrance of the development. Overhead lines will deliver the power to the main control switch. Underground cables will deliver power to the camping units, group shelters, and parking lot. Floodlights mounted on poles will be provided throughout the development. Lights are provided for boat ramps at the parking lot.

Garbage receptacles will be located conveniently throughout the area.

The total estimated installation cost for the recreation facilities is $86,400. Of this, $41,700 will be from P.L. 566 funds and $44,700 from other funds.

Debris Basins

Eight debris basins will be installed at locations shown on Figure 1. Principal features are shown on preliminary plans for a typical site on Figure 2. Each structure is designed to store the sediment volume expected to accumulate at the site over a 100-year period and automatically regulate the runoff from the 100-year storm. The structures will control damaging floods from drainages varying in size from 0.5 to 5.4 square miles. The storage capacity reserved for sediment will range from 58 acre feet to 228 acre feet. Floodwater storage capacity will range from 27 acre feet to 302 acre feet. Additional information concerning capacity, size, areas, and other details may be found in Table 3.

Each structure will consist of a low dam equipped with principal spillway to automatically retard floodwater and an emergency spillway in earth to pass floodwater in excess of the design capacity. The earth dams will be less than 30 feet in height with 2:1 and 3:1 slopes. The principal spillway will consist of a ported riser and outlet conduit designed to limit outflow at a rate non-damaging to downstream channels. The emergency spillways will be excavated in earth and will operate, on the average, not oftener than once in 100 years. The discharge capacity and other details of each emergency spillway is shown in Table 3.

The total installation cost for the debris basins is estimated to be $493,100. P.L. 566 funds will provide $478,600 and other funds $14,500 of this cost.

System Improvements

Improvements to be installed on the distribution systems include 101,200 feet of concrete canal lining, 3,000 feet of earth lining, 36,325 feet of canal relocation, 3 siphons, 3 flumes, 158 turnouts, 6 regulating reservoirs, 5 drop structures, 1 divider, 4,800 feet of control dike, and 20 acres of phreatophyte control. The lining will be of Portland cement concrete with bottom widths varying from 1.0 to 2.0 feet and depths from 1.0 to 3.0 feet. Capacities for this lining will vary from 5 to 40 cubic feet per second.

Capacities for the relocated canal sections and earth lined sections will vary from 5 to 190 cubic feet per second with bottom widths varying from 1 to 5 feet and depths from 1 to 6 feet. Relocated canals will improve grade and alignment. Earth linings will be machine placed and compacted. The siphons and flumes will be of welded steel pipe with concrete transition structures. The regulating reservoirs with about 20 acre feet capacity will consist of an earth fill dam with irrigation control outlet and emergency spillway. The turnouts will consist of a slide headgate with concrete headwall, and, in some cases, a short stub of pipe. The drop structures and the divider will be of reinforced concrete. The control dike will consist of earth embankment both above and below the south ditch to contain high flows. Phreatophyte control will consist of cutting, spraying, and removal of growth adjacent to the canals.

Principal features of irrigation structures are shown on Figure 6. These structures are designed to reduce seepage losses, enable the orderly and dependable distribution of water, and reduce excessive operation and maintenance costs. The estimated installation cost for these improvements is $387,200. P.L. 566 funds will provide $214,600 and other funds, $172,600 of the total cost.

Fish and Wildlife Water Resource Improvements

The Duck Fork and Willow Lakes irrigation reservoirs will be converted to fishery use. The fisheries are located on the Manti-LaSal National Forest as shown on Figure 1. Plans of the U. S. Forest Service include improvement of existing roads for public access to the reservoirs. Special-use permits for the improvements will require that perimeter access and use of the fishery be maintained for enjoyment of the general public, unrestricted by group or private developments along the shoreline. Principal features of the structures are shown on Figures 7 and 8.

Each structure is designed with a principal spillway and an emergency spillway. The principal spillway consists of a riser and outlet conduit. An appurtenant drainage gate with up-the-slope control will be affixed to the riser and conduit. The emergency spillway will be excavated in earth. The vertical distance between the crest elevations of the principal and emergency spillway and the corresponding surcharge storage volume have been carefully selected to prevent outflow through the emergency spillway for the design-emergency and freeboard hydrographs, as well as the 100-year frequency snowmelt inflow. The emergency spillways will not normally be used.

To convert the Duck Fork Reservoir to fishery use, it will be necessary to install a toe drain along a short section of the back toe of the dam, install a cutoff through a short section of the front slope of the dam, realign and renovate the present earth spillway, install a riser and drainage gate on the existing irrigation outlet, and reinforce the riprap along the exposed front slope of the dam. This will provide a permanent pool of 41 surface acres, 15 feet average depth, and a volume of 610 acre feet.

To create a fishery at the Willow Lakes site and minimize winter kill of fish, it will be necessary to raise the present fill and water surface by approximately 5 feet, install a cutoff at the upstream toe of the dam, install the principal and emergency spillways, and riprap the exposed face of the dam. This will provide a permanent pool with a surface area of 25 acres, an average depth of 10 feet, and give a storage volume of 235 acre feet.

The installation cost for these structures is estimated to be $256,800. P.L. 566 funds will provide $92,500 and other funds, $164,300.

Non-Project Measures

The Utah State Department of Fish and Game will convert and maintain the Ferron Reservoir to fishery use by installing a riser and drainage gate on the existing irrigation outlet. The estimated installation cost for the riser and appurtenances, $9,500, will be from Department funds.

EXPLANATION OF INSTALLATION COST

Costs

Land Treatment Measures

Installation costs for land treatment measures on private and state lands are estimates of all costs associated with establishing the measures. They include the application cost to be borne by individual owners and operators, together with cost sharing assistance as may be available through the Agricultural Stabilization and Conservation program administered by the Agricultural Stabilization and Conservation Service.

Installation costs for treatment measures on federal land includes the cost for establishing the treatment, associated technical services including soil surveys to determine suitability and exact location of the treatment, and overhead supervisory costs. Operation and maintenance costs reflect those needed to maintain the critical area treatment during the installation period for the treatment.

Estimates of quantities and costs for all land treatment measures are based upon surveys of watershed lands and on costs incurred for similar treatment in other projects. Application costs for each measure includes a contingency allowance to insure its establishment. All costs reflect current and local prices for the operations and services and materials involved in each practice. The estimated technical assistance costs for all measures is based upon an analysis of the costs for planning and applying similar measures.

Structural Measures

The installation costs shown in Tables 1 and 2 include all costs to be incurred in installing the structural measures. Installation costs include construction, installation services, land and water rights, and contract administration.

Construction costs shown for each structural measure represents a sound estimate for the cost of each contract for installing each measure. Construction costs consist of the engineer's estimated cost for each structural measure increased by 15% to 20% for contingencies. The engineer's estimated cost is a summation of the products of unit costs and the construction quantities included in the bid item schedules for each structural measure.

Installation services cost, based upon 25% of the contract cost, includes all personnel services cost associated with the survey, foundation and borrow investigations, design, preparation of contracts, and supervision of construction. Estimated installation services cost for installation of the recreation facilities include the required consultant engineering and architectural services in addition to installation services required for routine layout, review of designs, contracts, and incidental supervision of construction. Engineering services make up 68% of the installation services cost and other personnel services account for 32%.

Land rights costs consist of the value of the land, easements, or rights-of-way, cost of relocating facilities, and legal, survey, and other costs associated with their acquisition. The costs, $18,000, for relocation of the road around the Mill Site Reservoir and Dam is included. It is expected that the majority of the private land required for the smaller structures will be donated. Land right requirements for the Mill Site Reservoir and Dam include the cropland and farmstead of one farm unit. This farm unit will be purchased. Ferron City and Emery County will donate their interests in lands required for the Mill Site Reservoir and Dam. The irrigation company now owns 10 acres of required land. The recreation facilities will be located on federal land. Other public lands required--city, county, and federal--can be obtained with only legal and survey costs involved.

Costs for water rights for the water resource improvements for fish and wildlife were agreed upon by the Utah State Department of Fish and Game and the Ferron Canal and Reservoir Company.

Contract administration costs include all personnel services, overhead, and cash costs associated with administration of contracts. Contract administration costs shown for each structural measure, based upon the number of contracts and the cost of administering each, represents the experience of local sponsoring organizations in other watersheds where similar measures have been installed.

Cost Allocation and Cost Sharing

The installation costs for the Mill Site Reservoir and Dam were allocated to flood prevention, fish and wildlife development, and irrigation by the use of facilities method except that those costs of required lands, easements, and rights-of-way to be purchased for the reservoir allocated to fish and wildlife development were determined by the ratio of the difference between total area required and area required for other purposes to the total area. Approximately 72% of the installation cost of this structure is allocated to irrigation, 17% to flood prevention, and 11% to fish and wildlife development. All costs of the recreation facilities are allocated to the purpose of fish and wildlife development.

The debris basins, irrigation system improvements, and fish and wildlife water resource improvements are single purpose measures and the costs are allocated to the purposes served.

Sharing of project costs between P.L. 566 funds and other funds are in accordance with the provisions of Public Law 566, 83d Congress, 68 Stat. 666, as amended, and the Policy Statement of the Secretary of Agriculture. Project costs are estimated to be $6,969,800. Fifty-six percent or $3,892,100 will be provided from P.L. 566 funds. Other funds will provide $3,077,700 or forty-four percent. Non-project costs, $9,500, will be from other funds.

The following costs will be from P.L. 566 funds:

1. Cost of technical assistance for accelerated land treatment on non-federal land, $36,600.

2. Cost for applying accelerated land treatment measures on federal land, $841,700.

3. Federal share of the construction cost for structural measures as follows:

    a. 50% of the construction cost for the irrigation outlet for the Mill Site Reservoir and Dam, $32,000, and 58.8% of the remaining (joint) construction cost, $1,489,900.

b. 50% of the construction cost for recreation facilities, $33,400.

c. 50% of the construction cost for the system improvements, $143,000.

d. The construction cost of the debris basins, $382,700.

e. 50% of the construction cost for the Duck Fork and Willow Lakes fisheries, $61,600.

4. 33.8% of the cost for about 370 acres of required land to be purchased and road relocation for the Mill Site Reservoir and Dam, $14,500.

5. The cost of installation services for construction of the Mill Site Reservoir Dam, the system improvements, the debris basins, and the Duck Fork and Willow Lakes fisheries, $848,400.

6. 50% of the installation services cost for installation of the recreation facilities, $8,300. This cost includes the value of incidental engineering involved in layout and review of plans and contracts, as well as 50% of the cost for consultant architectural and engineering services.

The following costs will be from other funds:

1. Application cost for installation of land treatment measures on private and state land, estimated to be $246,200. Cost sharing assistance available under other programs at the time of installation will be utilized.

2. Cost of technical assistance for going program for land treatment measures on non-federal land, $18,800.

3. Application cost for land treatment measures to be installed on federal land under going program, $1,251,000.

4. Non-federal share of the construction cost for structural measures as follows:

a. 50% of the construction cost for the irrigation outlet for the Mill Site Reservoir and Dam, $32,000, and 41.2% of the remaining (joint) construction cost, $1,046,100.

b. 50% of the construction cost for recreation facilities, $33,400.

c. 50% of the construction cost for system improvements, $143,000.

d. 50% of the construction cost for the Duck Fork and Willow Lakes fisheries, $61,600.

5. 50% for consultant engineering and architectural services required for installation of the recreation facilities, $8,300.

6. 66.2% of the cost for 370 acres of required land to be purchased for road relocation for installation of the Mill Site Reservoir and Dam, $28,500, plus 100% of the cost of contiguous and other land which will be acquired, $10,000, and 100% of the survey and legal cost, $1,000, incurred in acquisition.

7. Land rights cost for installation of other structural measures, $21,900.

8. The costs for water rights, $100,000. This includes the cost for transfer of storage and water rights to operate the Duck Fork, Ferron, and Willow Lakes fisheries.

9. Costs for administering contracts for project installation, $75,900.

10. Non-project cost for conversion of the Ferron irrigation reservoir to fishery use, $9,500.

Schedule for Expenditure of Funds

Year	P.L. 566	Other	Total
1	$ 279,800	$ 260,900	$ 540,700
2	400,600	168,900	569,500
3	1,054,800	794,900	1,849,700
4	1,294,000	870,900	2,164,900
5	214,700	177,900	392,600
6	374,100	251,200	625,300
7	156,600	95,400	252,000
8	110,100	402,600	512,700
9	3,700	27,500	31,200
10	3,700	27,500	31,200
Total	$3,892,100	$3,077,700	$6,969,800

EFFECTS OF WORKS OF IMPROVEMENT

Treatment measures included in this plan are designed to alleviate the principal physical watershed problems and stabilize and improve the economy of the watershed. No additional land will be brought under irrigation or cultivation as a result of this project.

The total area benefited by flood prevention and irrigation measures is 12,125 acres. Of this amount, 6,525 acres of irrigated cropland and 5,600 acres of pasture will receive direct protection from floods. Of the 11,200 acres of cropland, 6,525 acres will be jointly benefited by flood control and irrigation measures and the balance of 4,775 irrigated acres will be benefited solely by irrigation measures.

The irrigation improvement measures will directly benefit 735 persons and the flood prevention measures, 800 individuals. There are 123 farm operating units in the watershed.

Stabilization of critical areas with land treatment measures will curb erosion, reduce floodwater and sediment production, and contribute to the effective operation and extend the useful life of the structural measures. Land treatment measures to be installed on individual farms will contribute to conservation use of water, soil and other farm resources.

The debris basins and the Mill Site Reservoir will virtually eliminate floodwater and sediment damages from the key flood source areas which they control. In addition, the Mill Site Reservoir will provide for effective regulation of flood flows and optimum seasonal distribution of the waters of Ferron Creek for efficient irrigation and enable the creation of a fishery and recreation complex, all of which will contribute materially to economic development and stability of the watershed. The improvements on irrigation company systems will reduce seepage losses and provide for effective and equitable distribution of irrigation water to the farms.

Conversion of the upstream reservoirs to fishery use will provide fish and wildlife water resource improvements to meet the needs of the area. These structures will also provide effective control of summer floods and the 100-year frequency snowmelt runoff from their drainage areas, which will benefit stream channels, roads, and other values in upstream watershed areas.

Floodwater and Sediment Reductions

Land treatment measures for stabilization of critical areas are an integrated approach toward alleviating flood and sediment damage problems. These measures will reduce flood runoff and sediment production at its source and arrest widespread erosion and land deterioration. Contour trenching and furrowing, pinon-juniper eradication, roadside erosion control, gully plugs, seeding, fencing of treated areas, and increased fire protection measures will stabilize critical sediment and flood source areas, rehabilitate deteriorated sites, and prevent the encroachment of active gullies onto adjacent lands. Fencing, water developments, brush control, plowing, and seedings of less critical areas will facilitate the management of critical areas and adjacent rangelands and distribution of livestock grazing in accordance with the needs and capabilities of the watershed lands.

Upper watershed treatment measures including adjustment of livestock use to the capacity of suitable range and improved management of all resources will contribute materially to the success of the project and the life of structural measures by decreasing flood flows and sediment loads. These reductions will gradually accrue and will reach maximum effectiveness in 40 to 50 years after establishment of the measures. It is estimated that the measures will give an average reduction of 20% in downstream damages. An added and proportionately higher offsite reduction in flood flows and sediment movement will occur throughout the upper watershed at points where flood flows now damage roads, trails, bridges, recreation sites, and grazing resources. It is estimated that average annual reductions of 35% in upstream damages will accrue from this treatment. Additional benefits in increased recreation use due to easier and more consistent access will be a substantial by-product of this treatment.

The debris basins and the Mill Site Reservoir will complement the land treatment program in giving flood protection to the irrigated land, cultural improvements, irrigation distribution systems, roads, and other fixed improvements. The water resource improvements for fish and wildlife will provide a limited amount of flood protection to stream channels, trails, and other values.

The debris basins will give protection from the 100-year frequency summer flood and virtually eliminate damage from sediment originating in their controlled drainage areas. On the flood fans and flood plain of the controlled drainages, 7,200 acres will receive complete protection from floods below the 100-year frequency level and 4,925 acres of fan and flood plain land will receive a high but lesser degree of protection because of the influence of small uncontrolled drainages and runoff below flood prevention structures.

The Mill Site Reservoir will virtually eliminate downstream sediment and flood damages. Sediment and debris which has formerly choked structures and filled channels and canals will be contained in the sediment pool. Summer floods occur at a time when storage capacity will be available in the irrigation pool to accommodate the flood volume. Snowmelt floods will be completely controlled through storage regulation. Reservoir operation, based upon runoff forecasts, will enable control of the larger and less frequent snowmelt floods.

The debris basins and the Mill Site Reservoir will give immediate and a high degree of protection from sediment and floodwater to the irrigated acreage, cultural improvements, and distribution systems. These structures will provide positive control of significant flood source areas. By protection of the irrigation distribution canals, effective and timely distribution of irrigation waters can be ensured. By protection of the irrigated land, key conservation practices may be applied which will increase the efficiency in use of irrigation supplies and contribute to a stable economic agricultural base for the community.

Effects of Irrigation Measures

The combined effects of on-farm land treatment and structural measures for irrigation will be to improve the use of land and water and induce a more efficient use of capital and labor resources. The on-farm land treatment will be applied more or less uniformly over the irrigated land. The improvement in irrigation water supply stemming from the Mill Site Reservoir and the system improvements will affect all of the irrigated land. There will be a shift in cropping pattern on 13% of the irrigated cropland reflecting an improved conservation cropping system and about 475 acres of wet pasture will be improved or upgraded to a more economic use.

Land treatment measures will improve irrigation efficiencies and promote the application of improved farm technology and management. Over-all transportation and farm efficiencies are expected to increase from 28% to 42%. The Mill Site Reservoir, through storage regulation, will affect the distribution of water throughout the irrigation season and permit water deliveries to more nearly coincide with the requirements of the crops. System improvements will reduce water losses and provide for orderly and timely distribution of water to the farm headgate.

Installation of accurate measuring and control devices within the system will permit a more equitable distribution of water among users and will provide a sound basis for improved water management throughout the system and on farms.

The effect of the project will be, through water conservation and storage regulation, to bring the distribution of water supply nearly in line with seasonal water requirements. Under present conditions, 47% of the seasonal water requirement can be met. Under project conditions, 80% of the seasonal water requirement can be met. Net farm income will have more than doubled after the farmers share of project costs have been deducted.

Other Effects

The inclusion of browse in the critical area seedings within key game ranges should increase the winter forage for deer. The direct improvement of forage on deer winter range produced by the establishment of browse and by adjustment of livestock grazing to the capacity of suitable range will induce a widespread improvement in vegetative cover in adjacent areas. Direct benefits to big game from the proposed treatment include increased forage production and improved condition of the deer herd. Effects will include better hunter success and quality game which will result in increased hunter use.

In addition to improvement in quantity and quality of plant cover, the seeded areas will also provide improved habitat for upland game birds. The installation of livestock watering facilities on the rangeland will also provide water for upland game birds and for deer. The watering facilities will extend the range and improve the survival ratio of upland game bird broods. The wildlife plantings in the irrigated area will provide much needed feed and cover.

The water resource improvements at the Mill Site Reservoir Dam and the fish and wildlife water resource improvements in the upper watershed will greatly enhance the fishery resources of the watershed and surrounding communities. It is estimated that the trout fishery to be established at the Mill Site would have an average annual use of about 19,800 angler days. It is estimated that the Willow Lakes and Duck Fork fisheries in the upper watershed would provide for 11,500 angler use days initially and build up to an average of 18,700.

The water resource development at the Mill Site will provide for boating in addition to fishing. The recreation facilities to be installed contiguous to the reservoir will provide a base for use of the reservoir for recreation activities in the surrounding area.

Kinds of use to be provided at the Mill Site Reservoir and the average number of activity days of use expected through the evaluation period are:

	Activity Days		
Activity	Projected Demand	Capacity	Expected Use
Picnicking	32,925	18,145	18,145 1/
Camping	9,570	2,270	2,270 1/
Boating	5,865	8,065	5,865 2/
Fishing	48,600	19,800	19,800 1/

1/ Limited by capacity
2/ Limited by demand

The reservoir will provide the only fishery and recreation facilities below 7,500 feet (mean sea level) in this part of the state and will be open for use much earlier and later in the season than other reservoirs, existing or proposed.

The base area from which this development will draw support includes Carbon and Emery counties and the Salina area of Sevier County. It is defined as being within the periphery of an area of one and one-fourth hour driving time of the development and has a projected 1980 population of 38,700. It will also provide facilities for tourists from Utah and surrounding states who regularly visit the watershed for camping, fishing, and related activities.

PROJECT BENEFITS

Major economic changes will be produced by the installation of this project in this watershed. With a static or diminishing level of activity in mining, declining range resources and other economic and social limitations which hinder the development of efficient family farm units, the economy of the area and the watershed is stagnant and depressed. This project offers an effective and practical means of rehabilitating the range resource, developing the recreation potential, and raising the income of farming units to levels which will accelerate the development of stable family farms.

Flood Prevention Benefits

The flood prevention structures are primarily designed to protect the two main irrigation canals and the farmland lying below. They will also give protection to roads, bridges, and farm structures and will insure the delivery of irrigation water to the farms.

Annual damage reduction benefits from the single purpose structural measures for flood prevention will total $27,720. In addition, secondary benefits of $2,325 and water conservation benefits of $3,440 will accrue. An additional $19,060 in flood prevention benefits will be generated by the multiple purpose Mill Site Reservoir.

The group of debris basins protecting the North Ditch will produce $12,315 in annual benefits, including $10,120 in primary flood prevention benefits and secondary and water conservation benefits of $950 and $1,245, respectively. Damages to crops, farmlands, irrigation facilities, roads, bridges, and farm structures will be reduced by 95%. About 55% of these benefits will accrue from reduction in damages to crops and irrigation facilities, 36% to farm structures, farmland, road, and miscellaneous items, and 9% in indirect damage.

The debris basins above the South Ditch will give total annual benefits of $21,170, including $17,600 in primary flood prevention benefits, $2,195 in water conservation benefits, and $1,375 in secondary benefits. Reductions in damages to crops, canals, and irrigation structures make up 53% of damage reduction benefits. Reduced damages to farmlands, roads, bridges, irrigation services and miscellaneous items include 39% of the reduction benefits. Reductions in indirect damages account for 8%. The total effect of these structures will be to reduce present damages by about 90%.

The combined effect of the Mill Site Reservoir in containing damaging sediment and in controlling flood flows would be to reduce flood and sediment damages by 83%. Damage reduction benefits total $19,060, and are made up of reductions in sediment deposition in canals, ditches, and farmland and in reductions in streambank cutting, damage to irrigation structures, and to crops. Reduction in sediment deposition damages in canals and on farmlands is 47% of total reductions. Damage reductions in crop, feed, and production materials and facilities make up 34% of the total. Indirect damage is 6% and the balance, 13%, is made up of damage reduction benefits to roads, bridges, farm structures, and miscellaneous items.

Irrigation Benefits

Under present conditions, the median water supply will meet about 47% of seasonal water requirements. With the project, the median water supply will meet about 80% of seasonal needs. This will produce total annual primary benefits of $327,380 and $51,085 in secondary benefits.

The principal benefit derived from the irrigation features of the Mill Site Reservoir will be generated by the storage and controlled release of irrigation water. Controlled release will enhance the value of the entire supply by inducing better irrigation application efficiency. Primary and secondary irrigation benefits of this structure will be $272,705 and $42,830 per year, respectively, after costs of accelerated land treatment have been deducted.

The irrigation system improvements will improve conveyance and operational efficiency and result in total benefits of $62,930 per year. This includes $54,675 in primary benefits and $8,255 in secondary benefits.

Fish and Wildlife and Recreation Benefits

Physical effects of the land treatment program with respect to big game and upland game birds have been detailed previously. These effects were not reduced to monetary benefits.

Water resource improvements for fish and wildlife, Willow Lakes, and Duck Fork Reservoir, in the upper watershed, will have benefits of $28,050 per year.

The water impounded in the Mill Site Reservoir and the picnic, boating, and camping facilities established on the shoreline will be extensively used. It is estimated that the combined total of use will average 32,255 visits per year. Total benefits from this use will be $47,745 per year. This includes $25,225 in annual benefits for the fish and wildlife pool and $22,520 in annual benefits for the recreation facilities.

Secondary Benefits

Local secondary benefits evaluated include those "stemming from" and "induced by" the installation of project measures. Secondary benefits were not evaluated from a national standpoint.

Local secondary benefits produced by reduction in damage to irrigation facilities and farmlands were evaluated at $3,960 annually. These are losses in off-farm returns when flood damages decrease the amount of agricultural products normally processed, transported, and marketed. Other benefits in the "stemming from" category will accrue from the increased livestock production stimulated by the improved water supply. Benefits in the amount of $32,735 per year will be produced by the Mill Site Reservoir and the irrigation system improvements.

Secondary benefits in the amount of $16,715 will be "induced" by the Mill Site Reservoir, the irrigation system improvement, and the land treatment measures. These will result from the increased requirements for production supplies, consumer goods and services arising from the expanded livestock production expected under project conditions.

Total annual secondary benefits "stemming from" and "induced by" is estimated to be $53,410 per year.

Redevelopment Benefits

As previously stated, the two-county, Carbon-Emery area, has a high unemployment rate and has been designated as a distressed area under the Area Redevelopment Administration. This problem is further compounded by a high level of under-employment in the agricultural sector of the economy. The basis for the distressed area classification is an unemployment rate of 8.6% in Emery County and a 31% level of part-time employment in agriculture.

In the watershed, the unemployment rate is lower (6.5%) but the level of under-employment closely parallels the condition in the county. On the 123 operating units in the watershed, it is estimated that the scale of operations limited by the present water supply provides for no more than about 87 man years of full employment annually. With the anticipated level of agricultural technology which can be expected in the future, and the increased operating efficiencies which will result, a reduction in this level of labor requirement is a likely prospect.

The installation of the project will provide an immediate stimulus to the local economy and will provide an improved production base which will return benefits far into the future. Since much of the required construction labor will be recruited from the local work force, installation of the structures will have a quick impact on the local economy. This will initiate a chain of secondary economic activities which will stimulate business throughout the watershed and the surrounding area.

It is estimated that installation of the structural measures and land treatment will generate local employment benefits of $681,625 over the 10 year installation period. When reduced to annual equivalents over a 100 year period, the benefit would be $23,755 per year.

The increased livestock production and the accelerated application of farm technology stimulated by project improvements will have a long and sustained effect in furnishing full farm employment and in raising the level of income on family farms. Marginal economic units will be strengthened and the current trend toward the development of larger and more efficient operating units will be accelerated. The increased labor inputs required to achieve project production levels are estimated to be at least 87,000 man hours per year. With an initial annual dollar value of $109,970, the benefit reduces to $30,510 per year when appropriately limited and adjusted.

After deducting the value of labor inputs, $3,050, counted as secondary benefits, total net redevelopment benefits from all sources are estimated to be $51,215 per year. These benefits are not used for project justification, but were defined and calculated so as to show the full scope of project effects.

The following table shows the change in farm income expected as a result of the project.

Farms by Economic Classes - Ferron Watershed

Value - Farm Products Sold	Economic Class	W/O Project 1/ No.	W/O Project 1/ %	With Project 1/ No.	With Project 1/ %
$ 50 - $ 2,499	6	51	45	25	24
2,500 - 4,999	5	16	14	20	20
5,000 - 9,999	4	32	28	14	14
10,000 - 19,999	3	9	8	28	28
20,000 - 39,999	2	6	5	9	9
40,000+	1	--	--	6	5
		114 2/	100	102 2/	100

1/ Projected.
2/ Reflects trend toward larger and fewer farms.

Benefits from Upper Watershed Treatment

Downstream damage reduction benefits from upper watershed land treatment will be $5,365 per year. None of these benefits are used for project justification.

COMPARISON OF BENEFITS AND COSTS

The over-all benefit-cost ratio for the project is 2.9 to 1.0 with annual benefits of $506,805 and annual costs of $172,975. The annual benefits are made up of $453,395 in primary benefits and $53,410 in secondary benefits. Without the inclusion of secondary benefits, the benefit-cost ratio is 2.6 to 1.0.

In addition, redevelopment benefits of $51,215 per year have been identified and evaluated but are not used in project justification.

The annual benefits, annual costs, and benefit-cost ratios for individual structures and groups of measures are shown in Table 6.

PROJECT INSTALLATION

This plan will be carried out as a joint undertaking of private, local, state, and federal interests.

Non-federal interests include individual farmers and ranchers, the San Rafael Soil Conservation District, Emery County Water Conservancy District, Ferron Canal and Reservoir Company, Ferron City, Emery County, Utah State Department of Fish and Game, Utah State Department of Forestry and Fire Control, Utah State Land Board, Utah Water and Power Board, and the Utah Cooperative Extension Service.

Participating federal agencies include the Soil Conservation Service, Forest Service, Bureau of Land Management, Farmers Home Administration, and the State and County Agricultural Stabilization and Conservation Committees.

Sponsoring organizations will acquire necessary lands, easements, and rights-of-way, execute agreements with owners of private lands for installation of the land treatment measures, provide the non-federal share of the installation cost of structural measures, and cooperate with other local, state, and federal agencies concerned with the project. Local sponsoring organizations will contract for construction of the structural measures in the work plan.

Sponsors will secure the necessary lands, easements, and rights-of-way by negotiation or will use their right of eminent domain. Necessary lands, easements, rights-of-way, and water rights will be secured for one or more construction units before federal financial assistance is made available for construction of any structural measures in the designated construction unit.

The San Rafael Soil Conservation District is empowered to enter into agreements and contracts, to sue and be sued, carry out soil and water conservation operations, and apply soil conservation treatment within the boundaries of the District.

Emery County Water Conservancy District has powers of eminent domain, may levy assessments, hold election for loan or bond authorization, make annual levies to retire these obligations, is empowered to enter into agreements and contracts, and may sue and be sued.

The Ferron Canal and Reservoir Company, legally organized under state laws, has powers of eminent domain, can accept contributions, and levy assessments against its stock for repayment of obligations and operation and maintenance costs.

Ferron City, incorporated under state laws of Utah, has powers of taxation, eminent domain, can accept contributions, levy assessments, hold elections for loan or bond authorization, make annual levies to retire these obligations, and enter into special-use agreements with land administering agencies for construction and maintenance of improvements.

Emery County has powers of taxation, eminent domain, can levy assessments, hold election for loan or bond authorization, make annual levies to retire these obligations, and enter into special-use agreements with land administering agencies for construction and maintenance of improvements.

The federal land administering agencies have concurred in the provisions of the work plan.

Responsibilities for Installation

In order to coordinate the installation of the accelerated land treatment and structural measures provided for in the plan and the going conservation programs within the watershed, close cooperation and specific responsibilities are required of private interests, the sponsors, local, state, and federal agencies assisting in this project.

San Rafael Soil Conservation District will:

1. Provide local leadership and direction which will continue the going program of the District at the rate which existed prior to development of this work plan.

2. Provide local leadership to insure the scheduled installation of the accelerated land treatment measures on private and state lands.

Ferron Canal and Reservoir Company will:

1. Confirm and keep their water rights for the project current.

2. Survey and acquire all needed lands, easements, and rights-of-way and record legal documents for installation of the debris basins, the Mill Site Reservoir and Dam and recreation facilities, and improvements on the company systems and on group systems serviced by the company.

3. Act as local contracting organization for the construction of these measures and furnish the non-federal share of the construction cost. By agreement with the company, the Utah State Department of Fish and Game will participate in the cost allocated to fish and wildlife in the Mill Site Reservoir.

4. Provide leadership, encourage and assist water users under their system to attain more efficient use of available water supplies through application of the scheduled land treatment measures and better water management practices.

5. By agreement with the Utah State Department of Fish and Game, transfer storage and water rights needed to establish and maintain fisheries at the Duck Fork, Willow Lakes, and Ferron Reservoir.

Utah State Department of Fish and Game will:

1. Acquire special-use permits and water rights for installation of the Duck Fork, Willow Lakes, and Ferron fisheries.

2. Act as local contracting organization for the construction of the Duck Fork and Willow Lakes fisheries. Furnish the non-federal share of the construction cost for these fisheries and operate the installations.

3. Participate with the irrigation company in the construction cost allocated to fish and wildlife storage in the Mill Site Reservoir. Develop the fishery potential of the Mill Site Reservoir.

4. Cooperate with local, state, and federal agencies in making exchange use agreements, range and vegetation surveys, utilization checks, or other studies involving forage utilization; manage fish and game resources of the project area within the scope of the Fish and Game Code of Utah, and continue big game harvesting programs which will maintain big game herds in balance with game forage production.

5. Develop upland game habitat on private land under the regular Department program in cooperation with the program of the San Rafael Soil Conservation District.

6. Maintain close liaison with sponsors and other agencies and groups participating in the project and assist in appropriate revisions of the work plan.

The Department will also install a riser with needed appurtenances to convert and maintain the Ferron irrigation reservoir to fishery use as a non-project measure.

The Emery County Water Conservancy District will:

1. Provide leadership, encouragement, and assistance to the Ferron Canal and Reservoir Company in meeting their responsibilities as outlined in this work plan.

2. Assist the irrigation company in procurement of necessary lands, easements, and rights-of-way for installation of the improvements.

3. Provide leadership and encouragement to the water users to obtain more efficient use of irrigation water and the accelerated application of related management practices.

Ferron City will:

1. Contribute their interests in lands and improvements which are valued at $7,500 as required for construction of the Mill Site Reservoir and Dam, the debris basins, and the system improvements.

2. Participate with the Soil Conservation Service and the irrigation company in construction schedules and manage the diversion of culinary water supply to facilitate construction of the Mill Site Reservoir Dam.

3. Provide the service of the city staff and the city-owned equipment, as available, in relocation of the road around the Mill Site Reservoir and Dam and in administering contracts.

Emery County will:

1. Provide leadership, encouragement, and assistance to the Ferron Canal and Reservoir Company in meeting their responsibilities as outlined in this work plan.

2. Contribute their interest in lands required for structural measures.

3. Assist the irrigation company in procurement of other lands, easements, and rights-of-way needed for installation of the structural improvements.

4. Provide leadership and encouragement to the water users to obtain more efficient use of irrigation water and the accelerated application of related management practices.

5. Cooperate in the surfacing of the relocated road serving the area.

The Soil Conservation Service will:

1. Furnish technical assistance through the San Rafael Soil Conservation District to private landowners for installation of land treatment measures on non-federal lands.

2. Furnish the installation services for engineering surveys, designs, construction plans and specifications, and construction supervision for installation of the Mill Site Reservoir and Dam, the system improvements, the debris basins, and the Duck Fork and Willow Lakes fisheries.

3. Furnish not more than 50% of the cost for required consultant engineering and architectural services and incidental engineering and other services involved in layout and review of plans and contracts for installation of the recreation facilities at the Mill Site Reservoir.

4. Provide construction funds for the project in accordance with the cost sharing and time schedules set forth herein or as revised by mutual agreement and in accordance with national priorities.

5. Maintain liaison with sponsors and state and federal agencies participating in the project to the end that unified effort and coordinated action will produce the most effective results. Consult with and assist the sponsoring organizations, local, state, and federal agencies, in making desirable revisions or amendments of this plan if and when circumstances dictate.

The U. S. Forest Service will:

1. Install the land treatment measures on National Forest land in accordance with the program outlined in Table 1.

2. Coordinate the treatment, use, and management of National Forest lands contiguous to other federal land to effect minimum treatment cost and optimum utilization by big game and livestock.

3. Furnish technical assistance for planning and application of practices under its Departmental responsibility for technical adequacy for woodland planning. This will be done in cooperation with the Utah State Department of Forestry and Fire Control.

4. Authorize access roads, borrow areas, and other land occupancy by special-use permits. These special-use permits will be issued and administered in accordance with established policies and procedures.

The Bureau of Land Management will:

1. Install the land treatment measures on federal land administered by the Bureau of Land Management in accordance with the program outlined in Table 1.

2. Coordinate the treatment, use, and management of treated areas contiguous to treatment areas of the National Forest to effect the least treatment cost and optimum utilization by livestock and big game.

3. Determine the suitable time for renewal of grazing use of the treatment areas.

4. Authorize access roads, borrow areas, and grant easements and rights-of-way in accordance with Bureau of Land Management policy and procedure for installation of the structural measures.

The following agencies, by agreement with the sponsors, will participate as shown:

Utah State Department of Forestry and Fire Control will:

1. Arrange for adequate fire presuppression and suppression with the local sponsors and provide fire suppression equipment as needed through its regular program.

Utah State Land Board will:

1. Participate with permittees and the San Rafael Soil Conservation District in the proper management of the grazing resources on the state land.

Utah Water and Power Board will:

1. To the extent permitted by state law, availability of funds, and Utah Water and Power Board regulations, make financial assistance available to the sponsors or water users.

The Utah Cooperative Extension Service will:

1. Give high priority in carrying out an effective education and information program in cooperation with the sponsors of this project.

The Agricultural Stabilization and Conservation Committees, State and County, will:

1. Give high priority to scheduling Agricultural Conservation Program funds to expedite the land treatment on private and state lands.

The Farmers Home Administration will:

1. Provide information and guidance to the local organizations regarding the requirements for Farmers Home Administration loans.

2. Make loan funds or advancements to local organizations desiring to use loan provisions of the Act to finance the local share of installation costs for works of improvement included in the plan.

3. Cooperate and collaborate with the Soil Conservation Service, the Soil Conservation District, and recipients of watershed loans in setting up inspection and operation and maintenance procedures for works to be installed with loans authorized under Section 8 of the Act.

4. Maintain close liaison with sponsors, agencies, and groups participating in this project and assist with appropriate revisions of the work plan.

Schedules for Installation

Going conservation programs of the San Rafael Soil Conservation District and federal and state agencies cooperating in this project are an integral part of this plan and will continue at least at the same rate that existed prior to development of the watershed work plan.

Installation of accelerated land treatment measures which have measurable effects in flood prevention will begin during the first year of the project and be completed during a 10-year project period. Treatment and adjustment in use will be made in accordance with the schedule for the installation of the structural measures. The effect on normal farm and ranch operation was considered in developing the schedules for installation and will be considered in any adjustments in scheduling during the installation period.

The installation of accelerated land treatment measures which have a measurable effect in reducing water losses and increasing on-farm irrigation efficiencies will begin in the first year of the project and be completed during a 10-year installation period. The systematic installation of the on-farm measures concurrently with the Mill Site Reservoir and Dam and irrigation system improvement structural measures is essential to the successful application of the provisions of this plan. Accordingly, the scheduled assistance for the installation of structural measures for irrigation will depend on substantial year-by-year progress in the installation of the on-farm measures.

The installation of the structural program for flood prevention is scheduled concurrently with or after the installation of required land treatment above the structures. The installation of the structural irrigation measures is scheduled concurrently with the installation of the on-farm land treatment measures.

The proposed installation schedule follows:

Federal Land (BLM)

1st year
Install treatment, 1,119 acres: Herring Flat--contour furrow 731 acres; Salt Wash--contour furrow 388 acres, construct 1 large gully plug, and construct 2 miles of fence.

2nd year
Install treatment, 1,039 acres: N. W. Ferron--contour furrow 925 acres, construct gully plugs 114 acres, construct 8 large gully plugs and 6 stockwater reservoirs. Maintain previously installed treatment.

3rd year
Install treatment, 540 acres: Salt Wash--contour furrow 540 acres, construct 1 large gully plug. Maintain previously installed treatment.

4th year
Install treatment, 970 acres: Salt Wash--contour furrow 970 acres. Maintain previously installed treatment.

5th year
Install treatment, 171 acres: Salt Wash--contour furrow 171 acres. Maintain previously installed treatment.

6th year
Install treatment, 1,433 acres: N. E. Ferron--contour furrow 1,433 acres and construct 2 miles of protective fence. Maintain previously installed treatment.

7th year
Install treatment, 1,618 acres: N. E. Ferron--contour furrow 1,618 acres. Maintain previously installed treatment.

Manti-LaSal National Forest (FS)

1st year
Install treatment on 3,620 acres: McEwan Flat--contour furrow 520 acres, spray sagebrush 307 acres, construct 1 mile of fence and close 1 mile of irrigation ditch; Black Dragon--contour trench 235 acres, contour furrow 303 acres, chain 410 acres of pinon-juniper, and stabilize 8 miles of road erosion; Kitchen--contour trench 105 acres, contour furrow 378 acres, spray 160 acres of sagebrush, and stabilize 1.5 miles of road erosion; Lower Bear Creek--contour trench 212 acres, contour furrow 195 acres, spray 115 acres of sagebrush, construct 2 miles of fence, and stabilize 0.5 miles of road erosion; Biddlecome Ridge--contour furrow 180 acres and chain 500 acres of pinon-juniper. Construct 7 miles of common use segregation fence and install the wildlife water developments on Nelson and Dry Mountains and in Dry Wash.

2nd year
Install treatment on 1,184 acres: Buck Ridge--contour trench 205 acres and construct 1.1 miles of gully stabilization; Little Bear Creek--contour trench 418 acres, contour furrow 80 acres, and construct 0.6 miles of gully stabilization; Big Bear Creek--contour trench 353 acres, contour furrow 128 acres, and stabilize 1.4 miles of gully erosion; North Side of Ferron Mountain--construct 12 miles of unit cattle fence. Maintain previously installed treatment.

3rd year
Install treatment on 770 acres: Lake Mountain and Cove Mountain--contour trench 200 acres, contour furrow 325 acres, stabilize 3 miles of road erosion and construct 0.7 miles of gully stabilization; Trail Ridge--contour trench 180 acres, contour furrow 65 acres, and stabilize 1.1 miles of gully erosion. Construct 5.0 miles of Ferron-Mayfield road. Maintain previously installed treatment.

4th year
Install treatment on 6,125 acres: Dairy Creek and Stevens Creek--contour trench 805 acres, contour furrow 1,992 acres, plow and seed 373 acres, aerial seed (aspen type) 2,500 acres, chain 390 acres of pinon-juniper, stabilize 12 miles of road erosion, construct 0.2 miles of gully stabilization, and construct 4 miles of fence; South Horn Mountain--contour trench 395 acres, contour furrow 1,277 acres, spray 820 acres of sagebrush, construct 1.0 mile of gully stabilization, stabilize 2 miles of road erosion, and construct 3 tank type water developments. Construct 5.0 miles of Ferron-Mayfield road. Maintain previously installed treatment.

5th year
Install treatment on 550 acres: George's Fork, Lake Fork, Duck Fork, and Indian Creek--contour trench 270 acres, contour furrow 280 acres, stabilize 10 miles of road erosion, and construct 2.5 miles of gully stabilization. Maintain previously installed treatment.

6th year
Install treatment on 1,925 acres: South Side of Cap of Horn Mountain--contour trench 1,351 acres, contour furrow 360 acres, spray 62 acres of sagebrush, stabilize 9 miles of road erosion, and chain 153 acres of pinon-juniper. Construct 5.0 miles of Ferron-Mayfield road. Maintain previously installed treatment.

7th year
Install treatment on 638 acres: Buck Flat and Ferron Mountain--contour trench 183 acres, contour furrow 440 acres, spray 15 acres of sagebrush, stabilize 2 miles of road erosion, and construct 2.3 miles of gully stabilization. Maintain previously installed treatment.

8th year
Install treatment on 756 acres: Wrigley Creek and Dry Wash--contour trench 318 acres, contour furrow 375 acres, plow and seed 63 acres, stabilize 2 miles of road erosion, and construct 0.3 miles of gully stabilization. Construct 6.0 miles of Skyline Drive road. Maintain previously installed treatment.

Utah State Department of Fish and Game

1st year
Acquire water rights and submit application for special-use permits for the fisheries. Survey and prepare designs and contract for the Duck Fork fishery. Survey and make needed investigations at the Willow Lakes site.

2nd year
Prepare designs and contract for the Willow Lakes fishery. Construct the Duck Fork fishery.

3rd year
Construct the Willow Lakes fishery and maintain and operate the Duck Fork fishery.

Ferron Canal and Reservoir Company

1st year
Make surveys and acquire lands, easements, and rights-of-way for the Mill Site Reservoir Dam and for 1/6 of the group irrigation system improvements. Investigate the Mill Site Reservoir Dam.

2nd year
Make surveys and acquire lands, easements, and rights-of-way for the canals, debris basins, and 1/6 of the group irrigation system improvements. Investigate the debris basin sites. Prepare designs and contracts for the Mill Site Dam and the group irrigation system improvements.

3rd year
Construct 1/6 of the group irrigation system improvements and 1/2 of the Mill Site Reservoir Dam. Make surveys, and acquire lands, easements, and rights-of-way for 1/6 of the group irrigation system improvements. Prepare designs and contracts for the debris basins and irrigation company system improvements.

4th year
Complete construction of the Mill Site Reservoir Dam. Construct the Diversion Hollow and Indian Hollow debris basins, 1/5 of the irrigation company system improvements and 1/6 of the group irrigation system improvements. Make surveys and acquire lands, easements, and rights-of-way for 1/6 of the group irrigation system improvements.

5th year
Construct the Mill Site Reservoir recreation facilities. Construct the Eli Hollow and Jewkes Hollow debris basins, 1/5 of the irrigation company system improvements, and 1/6 of the group irrigation system improvements. Make surveys and acquire lands, easements, and rights-of-way for 1/6 of the group irrigation system improvements.

6th year
Construct the Herring Flat-Zwahlen Wash and Straight Hollow debris basins, 1/5 of the irrigation company system improvements, and 1/6 of the group irrigation system improvements. Make surveys and acquire lands, easements, and rights-of-way for 1/6 of the group irrigation system improvements.

7th year
Construct the Dutch Flat debris basin, 1/5 of the irrigation company system improvements, and 1/6 of the group irrigation system improvements.

8th year
Construct the remaining irrigation company system improvements and the group irrigation system improvements.

FINANCING PROJECT INSTALLATION

Sponsoring local organizations are legally organized under state laws and are empowered and qualified to install, operate, and maintain project measures included herein. They have reviewed the program costs outlined in Tables 1 and 2 and have participated in cost-sharing decisions. They have given the Soil Conservation Service adequate assurance that their share of the installation cost will be available at the time and in the amounts required.

None of the sponsors has a history of delinquency.

Installation costs allocated to P.L. 566 funds will be from funds appropriated under the authority of Public Law 566, 83d Congress, 68 Stat. 666, as amended. This work plan does not constitute a financial document for obligation of federal funds, and financial or other assistance by the Soil Conservation Service is contingent upon the appropriation of funds for this purpose.

Cost sharing and other assistance currently available through going conservation programs of the San Rafael Soil Conservation District, the Agricultural Conservation Program, and other federal and state agencies cooperating in this project are an integral part of this plan and will be expected to be available at least in the amounts and rates that existed prior to the development of this work plan.

Land Treatment Measures

The cost for applying land treatment measures on private and state land will be from individual landowners, operators, and leasees utilizing cost-sharing assistance available through the Agricultural Conservation Program.

The County and State Agricultural Stabilization and Conservation Committees have reviewed land treatment needs for private and state lands and will endeavor to provide the funds required for accelerating the installation of these measures.

Technical assistance will be provided through the going program of the San Rafael Soil Conservation District at the current rate for installation of the going program on private and state lands. P.L. 566 funds will be provided for technical assistance needed for installation of the accelerated land treatment program on private and state lands.

Accelerated land treatment measures on federal land will be financed jointly from P.L. 566 funds and from regular funds of the land administering agencies. The going program for federal lands will be financed from funds of the land administering agencies, subject to their availability.

Structural Measures

The structural measures are located on federal, non-federal-public, and private lands. Land rights required for installation of structural measures on federal land administered by the Bureau of Land Management may be obtained by filing a right-of-way application with the Bureau. Land rights required on federal land administered by the Forest Service may be obtained by filing an application for special-use permit. In either case, only a small cost, including legal, survey, and other incidental costs, will be involved. Non-federal-public lands required for installation of structural measures can be obtained with only legal, survey, and other incidental costs involved. Most of the private land required for the flood prevention and system improvement measures will be donated. Remaining private lands required will be acquired by purchase. Contracts will be administered by the officers or regular employees of the irrigation company with material assistance from the regular staffs of Emery County, Ferron City, and Emery County Water Conservancy District.

The Ferron Canal and Reservoir Company intends to use loan provisions of Section 8 of the Act to help finance their share of the installation cost for measures which they sponsor. The company has filed a letter of intent with the State Director of the Farmers Home Administration outlining the need for credit in the amount of $1,175,000. Negotiations and investigations are underway to insure that needed credit will be available at the time and in the amount required.

Repayment of the loans will be provided through assessment of stock and through contracts with water users on group laterals.

The Utah State Department of Fish and Game will participate in the construction cost of the Mill Site Reservoir and Dam. The Department will also acquire water and storage rights for the fisheries. They will finance their share of project costs from regular sources of revenue of the Department.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures to be installed on private and leased state lands will be operated and maintained by private owners and operators through private initiative and conservation plans with the San Rafael Soil Conservation District.

Land treatment measures on federal land will be operated and maintained by the land administering agency. Operation and maintenance costs for critical area treatment on federal land will be from P.L. 566 funds as shown on Table 1, during the installation period for these measures, and thereafter from regular funds of the land administering agency. Operation and maintenance costs for other land treatment measures on federal land will be from regular funds of the land administering agency.

Structural Measures

Representatives of the Soil Conservation Service and the local sponsoring organizations will inspect all structural measures annually and after all floods. Required maintenance will be determined at this time. The responsible local organization will perform the needed maintenance work.

Specific operation and maintenance agreements between the sponsoring local organizations and the Service covering all phases of operation and maintenance will be executed prior to the issuance of invitations to bid.

Mill Site Reservoir

The Ferron Canal and Reservoir Company will be responsible for operation and maintenance of the Mill Site Reservoir and Dam.

The irrigation company will take steps necessary to ensure that the structure is operated for flood prevention, irrigation, and fish conservation in accordance with applicable state laws. The irrigation company will operate the irrigation outlet works. The irrigation company and the Utah State Department of Fish and Game will jointly provide for the fishery pool as described under "Works of Improvement to be Installed." The irrigation outlet works and the emergency spillway will not be altered in any way without the consent of the Soil Conservation Service.

Principal items of maintenance will include, but not be limited to, keeping the outlet works in satisfactory operating condition and removing trash and debris which might affect the operation of the structure from the reservoir area. Principal elements of this structure are designed for a useful life of 100 years. Annual operation, maintenance, and replacement costs are estimated to be $4,000.

Recreation Facilities

The Ferron Canal and Reservoir Company and Ferron city will be responsible for operation, maintenance, and replacement of the recreation facilities.

Preventive maintenance and replacement will be performed on an annual basis. Minor repairs will be made as required.

Operation of the installation will include the servicing of comfort stations and sanitary receptacles, irrigation of grass and shrubs, and the collection of charges.

The company will provide a caretaker to operate the installation. The company and Ferron city will provide jointly for manpower and equipment needed for servicing and maintaining the installation.

Annual operation and maintenance costs are estimated to be $5,000. Annual replacement costs are estimated to be $2,500.

An estimated charge of $0.75 will be made for each automobile as the entrance fee to the picnic and camping facilities. An estimated charge of $0.50 will be made for use of the boat ramp. No charge will be made for fishing privileges. It is expected that these charges, based upon expected use, will meet the needs for operation and maintenance and return the original investment to the local sponsors over the life of the project. Annual returns from the charges are estimated to be about $8,750 initially.

Debris Basins

The Ferron Canal and Reservoir Company will be responsible for operation and maintenance of the debris basins. The irrigation company will also be responsible for replacement of appurtenances having a useful life less than 100 years. Emery County and Ferron city will provide equipment and manpower available at the time maintenance is required to assist the company with their responsibility. The Emery County Water Conservancy District will provide funds in the amounts available at the time maintenance is required to assist the company.

The irrigation company will take steps necessary to insure that the structures function in the manner for which they were designed and in accordance with applicable state laws. The principal and emergency spillways for the debris basins will not be altered in any way without the consent of the Soil Conservation Service.

Principal items of maintenance will include but not be limited to, the spreading or removal of local sediment deposits which might affect the operation of the principal or emergency spillways and removal of trash and rubbish from all structures after every flood. The principal spillway of each structure will be replaced at the end of its physical life, estimated to be 50 years. Replacement costs are included below.

Total annual operation, maintenance, and replacement costs are estimated to be $1,030.

System Improvement Measures

The Ferron Canal and Reservoir Company will be responsible for operation, maintenance, and replacement of all system improvement measures. Respective segments of the company membership will operate, maintain, and replace specific improvements in accordance with supplemental agreements with the irrigation company with approval of the Soil Conservation Service.

The irrigation company will take steps necessary to insure that the planned measures are operated and maintained for the purpose and in the manner intended. The planned measures will be operated to distribute reservoir and natural flow irrigation water. Maintenance of the system improvements will consist primarily of keeping all facilities in satisfactory operating condition by making any necessary repairs to linings, berms, and appurtenances, removing of trash and obstructions, and replacing elements of the facilities at the end of their useful life. The average physical life of the system improvement is estimated to be 25 years. Annual operation, maintenance, and replacement costs for these measures are estimated to be $10,050.

Duck Fork and Willow Lakes Water Resource Improvements

The Utah State Department of Fish and Game will operate and maintain these facilities and replace elements of the structures at the end of their physical life in accordance with agreements with the Soil Conservation Service and within the provisions of the special-use permits issued by the U. S. Forest Service.

The Department will take steps necessary to insure that the structures are operated in a manner to serve the purpose intended.

Principal items of maintenance will include, but not be limited to, the removal of trash and rubbish from the perimeter, surface area, and principal spillway periodically, and maintenance of the fill, principal and emergency spillways, and riprap in a good state of repair. The Department will operate the reservoirs to maintain a satisfactory fishery. The principal spillways, including outlet conduit, riser, trash rack and fish screen, and drainage gate will be replaced when needed. Annual operation, maintenance, and replacement costs are estimated to be $500.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS

Ferron Watershed, State of Utah

Installation Cost Item	Unit	Number			Estimated Cost (Dollars) 1/						TOTAL
					P.L. 566 Funds			Other			
		Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	
LAND TREATMENT											
Soil Conservation Service											
Conservation Treatment											
Cropland (Irrigated)	Acres		8,330	8,330					198,100	198,100	198,100
Grassland (Irrigated)	Acres		3,320	3,320					44,100	44,100	44,100
Rangeland	Acres		18,580	18,580					4,000	4,000	4,000
Technical Assistance						36,600	36,600		18,800	18,800	55,400
SCS Subtotal						36,600	36,600		265,000	265,000	301,600
Forest Service											
Contour Trench	Acres	5,230		5,230	388,600		388,600				388,600
Contour Furrow	Acres	6,843		6,843	183,100		183,100				183,100
Pinon-Juniper Control	Acres	1,453		1,453	15,500		15,500				15,500
Roadside Erosion Control	Miles	50		50	31,800		31,800				31,800
Gully Plugs	Miles	11.1		11.1	29,500		29,500				29,500
Access Roads	Miles	16.0		16.0	25,500		25,500				25,500
Increased Fire Protection					400		400				400
Recreation and Construction Improvement								125,000		125,000	125,000
Road Construction and Improvement	Miles	21		21				712,000		712,000	712,000
Sagebrush Spraying	Acres	1,479		1,479				7,400		7,400	7,400
Plow and Seed	Acres	436		436				5,200		5,200	5,200
Fencing	Miles	26		26				49,400		49,400	49,400
Aerial Reseeding	Acres	2,500		2,500				15,000		15,000	15,000
Water Development (Livestock)	No.	3		3				4,500		4,500	4,500
Water Development (Wildlife)	No.	3		3				2,400		2,400	2,400
Irrigation Ditch Closure	Miles	1		1				500		500	500
Resource Management								280,000		280,000	280,000
Operation and Maintenance (Installation Period)					54,000		54,000				54,000
FS Subtotal					728,400		728,400	1,201,400		1,201,400	1,929,800
Bureau of Land Management											
Contour Furrowing	Acres	6,776		6,776	101,600		101,600				101,600
Gully Plugs	Acres	114		114	1,700		1,700				1,700
Gully Plugs	No.	10		10				9,000		9,000	9,000
Fencing	Miles	4		4				4,000		4,000	4,000
Stockwater Development	No.	6		6				5,400		5,400	5,400
Operation and Maintenance (Installation Period)					10,000		10,000	1,200		1,200	11,200
Resource Management								30,000		30,000	30,000
BLM Subtotal					113,300		113,300	49,600		49,600	162,900
TOTAL LAND TREATMENT					841,700	36,600	878,300	1,251,000	265,000	1,516,000	2,394,300
STRUCTURAL MEASURES											
Soil Conservation Service											
Mill Site Reservoir	No.		1	1		1,521,900	1,521,900		1,078,100	1,078,100	2,600,000
Recreation Facilities	No.	1		1	33,400		33,400	33,400		33,400	66,800
Canal Lining - Concrete	Feet		101,200	101,200		105,300	105,300		105,300	105,300	210,600
Canal Lining - Earth	Feet		3,000	3,000		1,750	1,750		1,750	1,750	3,500
Canal Relocation	Feet		36,325	36,325		8,900	8,900		8,900	8,900	17,800
Siphons	No.		3	3		2,850	2,850		2,850	2,850	5,700
Flumes	No.		3	3		600	600		600	600	1,200
Turnouts	No.		158	158		11,900	11,900		11,900	11,900	23,800
Regulating Reservoirs	No.		6	6		5,800	5,800		5,800	5,800	11,600
Drop Structures	No.		5	5		1,850	1,850		1,850	1,850	3,700
Dividers	No.		1	1		1,150	1,150		1,150	1,150	2,300
Dike	Feet		4,800	4,800		1,000	1,000		1,000	1,000	2,000
Phreatophyte Control	Acres		20	20		1,900	1,900		1,900	1,900	3,800
Debris Basins	No.	4	4	8	130,300	252,400	382,700				382,700
Willow Lakes Fishery	No.	1		1	34,000		34,000	34,000		34,000	68,000
Duck Fork Fishery	No.	1		1	27,600		27,600	27,600		27,600	55,200
SCS Subtotal					225,300	1,917,300	2,142,600	95,000	1,221,100	1,316,100	3,458,700
Subtotal - Construction					225,300	1,917,300	2,142,600	95,000	1,221,100	1,316,100	3,458,700
Installation Services											
Soil Conservation Service											
Engineering Services					44,900	528,300	573,200	4,100		4,100	577,300
Other Services					27,000	256,500	283,500	4,200		4,200	287,700
SCS Subtotal					71,900	784,800	856,700	8,300		8,300	865,000
Subtotal - Installation Services					71,900	784,800	856,700	8,300		8,300	865,000
Other Costs											
Land, Easements, and Rights-of-way						14,500	14,500	4,000	57,400	61,400	75,900
Contract Administration								9,000	66,900	75,900	75,900
Water Rights								100,000		100,000	100,000
SCS Subtotal						14,500	14,500	113,000	124,300	237,300	251,800
Subtotal - Other Costs						14,500	14,500	113,000	124,300	237,300	251,800
TOTAL STRUCTURAL MEASURES					297,200	2,716,600	3,013,800	216,300	1,345,400	1,561,700	4,575,500
TOTAL PROJECT					1,138,900	2,753,200	3,892,100	1,467,300	1,610,400	3,077,700	6,969,800
SUMMARY											
SCS Subtotal					297,200	2,753,200	3,050,400	216,300	1,610,400	1,826,700	4,877,100
FS Subtotal					728,400		728,400	1,201,400		1,201,400	1,929,800
BLM Subtotal					113,300		113,300	49,600		49,600	162,900
TOTAL PROJECT					1,138,900	2,753,200	3,892,100	1,467,300	1,610,400	3,077,700	6,969,800

January 1965

1/ Price base 1964

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of Work Plan Preparation)

Ferron Watershed, Utah

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Soil Conservation Service			
Irrigated Land			
Ditch Lining	L.F.	2,686	3,500
Land Leveling	Acres	125	7,500
Land Smoothing	Acres	150	1,500
Small Structures	No.	100	400
Farm Ponds	No.	26	1,300
Regulating Reservoirs	No.	4	3,000
Pasture Planting	Acres	500	4,000
Forest Service - Manti-LaSal National Forest			
Revegetation of Critical Areas	Acres	2,360	47,200
Fencing	Miles	12	23,800
Stockwater Development	No.	9	1,400
Resource Management			250,000
Bureau of Land Management			
Fencing	Miles	23.4	18,700
Experimental Vegetal Plots	No.	1	250
Cattle Guards	No.	2	650
Reservoirs	No.	3	2,300
Resource Management			27,000
STRUCTURAL MEASURES			
Soil Conservation Service			
Ditch and Canal Lining	L.F.	9,000	20,000
Canal Realignment	Miles	1	6,300
Irrigation Structures (small)	No.	60	3,000
Irrigation Structures (large)	No.	12	10,000
Irrigation Reservoir	No.	1	20,000
TOTAL	XXXX	XXXXX	451,800

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1/ Price base 1964

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Ferron Watershed, State of Utah

(Dollars) 1/

Structure Site No. or Name	Installation Cost - P.L. 566 Funds					Installation Cost - Other Funds						Total Install. Cost
		Install. Service						Other				
	Con-struc-tion	Engin-eering	Other	Ease-ments and R/W	Total P.L. 566	Con-struc-tion	Install. Service	Admin. of Con-tracts	Ease-ments and R/W	Water Rights	Total Other	
Mill Site Reservoir												
Total Cost	1,521,900	442,000	208,000	14,500	2,186,400	1,078,100		48,000	39,500 2/		1,165,600	3,352,000
Joint Cost	(1,489,900)	(442,000)	(208,000)	(14,500)	(2,154,400)	(1,046,100)		(48,000)	(39,500)		(1,133,600)	(3,288,000
Irrigation Outlet	(32,000)				(32,000)	(32,000)					(32,000)	(64,000)
Recreation Facilities	33,400	4,200	4,100		41,700	33,400	8,300	3,000			44,700	86,400
Canal Lining - Concrete	105,300	35,600	17,000		157,900	105,300		10,600	10,600		126,500	284,400
Canal Lining - Earth	1,750	600	300		2,650	1,750		200	100		2,050	4,700
Canal Relocation	8,900	3,000	1,500		13,400	8,900		900	900		10,700	24,100
Siphons	2,850	1,000	400		4,250	2,850		300	300		3,450	7,700
Flumes	600	300	100		1,000	600		100	100		800	1,800
Turnouts	11,900	3,900	1,900		17,700	11,900		1,200	1,200		14,300	32,000
Regulating Reservoirs	5,800	1,900	900		8,600	5,800		600	600		7,000	15,600
Drop Structures	1,850	700	300		2,850	1,850		200	200		2,250	5,100
Dividers	1,150	400	200		1,750	1,150		100	100		1,350	3,100
Dike	1,000	400	200		1,600	1,000		200	200		1,400	3,000
Phreatophyte Control	1,900	600	400		2,900	1,900		500	400		2,800	5,700
Debris Basins												
Jewkes Hollow	26,500	4,000	2,700		33,200			1,000	700		1,700	34,900
Eli Hollow	44,600	6,700	4,500		55,800			1,000	800		1,800	57,600
Indian Hollow	60,600	9,100	6,100		75,800			1,000	700		1,700	77,500
Diversion Hollow	37,900	5,700	3,800		47,400			1,000	600		1,600	49,000
Zwahlen-Herring	105,200	15,800	10,500		131,500			1,000	1,700		2,700	134,200
Straight Hollow (N)	18,300	2,800	1,800		22,900			1,000	600		1,600	24,500
Straight Hollow (S)	48,700	7,300	4,900		60,900			1,000	800		1,800	62,700
Dutch Flat	40,900	6,200	4,000		51,100			1,000	600		1,600	52,700
Willow Lakes Fishery	34,000	11,600	5,400		51,000	34,000		1,000	500	50,000	85,500	136,500
Duck Fork Fishery	27,600	9,400	4,500		41,500	27,600		1,000	200	50,000	78,800	120,300
(Ferron Fishery - Non-Project)						(7,500)	(2,000)					(9,500)
GRAND TOTAL	2,142,600	573,200	283,500	14,500	3,013,800	1,316,100	8,300	75,900	61,400	100,000	1,561,700	4,575,500

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1/ Price base 1964.

2/ $43,000, cost for 370 acres of required land and road relocation, will be cost shared, P.L. 566 cost $14,500, other funds, $28,500; $11,000 for contiguous land, legal, survey and other costs are not cost shared.

TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Ferron Watershed, Utah

(Dollars) 1/

Item	Purpose				
			Fish and Wildlife		
	Flood Prevention	Irrigation	Development	Water Resource Improvement	Total
		COST ALLOCATION			
Single Purpose Structures:					
Debris Basins	$ 493,100				$ 493,100
System Improvements		$ 387,200			387,200
Water Resource Improvements				$256,800	256,800
Multiple Purpose Structure:					
Reservoir Dam	570,900	2,393,100	$388,000		3,352,000
Recreation Facilities			86,400		86,400
TOTAL	$1,064,000	$2,780,300	$474,400	$256,800	$4,575,500
		COST SHARING			
Single Purpose Structures:					
P.L. 566	$ 478,600	$ 214,600		$ 92,500	$ 785,700
Other	14,500	172,600		164,300	351,400
Multiple Purpose Structure: Reservoir Dam					
P.L. 566	557,600	1,401,400	$227,400		2,186,400
Other	13,300	991,700	160,600		1,165,600
Recreation Facilities:					
P.L. 566			41,700		41,700
Other			44,700		44,700
TOTAL	$1,064,000	$2,780,300	$474,400	$256,800	$4,575,500

1/ Price base 1964

January 1965

TABLE 2B - ESTIMATED CONSTRUCTION COST

RECREATION FACILITIES

Ferron Watershed, Utah

Item	Unit	No.	Construction Cost (Dollars) 1/
Boat Ramps	No.	2	4,200
Roads - Access and Interior	Ft.	2,400	3,100
Parking Lot	No.	1	1,600
Camping Units	No.	19	8,900
Group Picnic Shelter	No.	1	3,000
Comfort Stations	No.	2	11,500
Landscaping	Job	1	5,750
Barriers	---	---	5,750
Water System (culinary and irrigation)	Job	1	11,500
Electric Power	Job	1	11,500
Total			66,800

1/ Price base 1964 January 1965

TABLE 3 - STRUCTURE DATA

WATER SUPPLY RESERVOIR AND DEBRIS BASINS

Ferron Watershed, Utah

ITEM	UNIT	Water Supply Reservoir Mill Site	Debris Basins: Jewkes Hollow	Eli Hollow	Indian Hollow	Diversion Hollow	Zwahlen Wash-Herring Flat	Straight Hollow North	Straight Hollow South	Dutch Flat	TOTAL
Drainage Area	sq. mi.	157.2	1.2	1.4	2.2	1.3	5.4	0.5	2.1	1.0	172.3
Storage Capacity											
Sediment	ac. ft.	5,800	91	102	98	78	223	58	109	82	6,641
Floodwater	ac. ft.		78	90	109	65	302	27	137	62	870
Recreation	ac. ft.	2,000									2,000
Irrigation Storage	ac. ft.	10,200									10,200
Total	ac. ft.	18,000	169	192	207	143	525	85	246	144	19,711
Surface Area											
Sediment Pool	acres	160	8	12	6	5	28	5	11	8	239
Floodwater Pool	acres		17	25	18	11	70	11	28	19	195
Recreation Pool	acres	236									236
Irrigation Storage	acres	420									420
Volume of Fill	cu. yds.	2,485,000	28,000	54,080	79,500	59,000	154,800	17,600	58,000	53,000	2,988,980
Elevation Top of Dam 1/	feet	1,059.0	103.5	114.0	122.0	949.0	114.5	105.0	104.5	95.0	XXXXXX
Maximum Height of Dam	feet	114	26	16	24	14	19	25	25	20	XXXXXX
Emergency Spillway											
Crest Elevation 1/	feet	1,049.0	100.5	111.0	119.0	946.0	111.5	102.0	101.5	92.0	XXXXXX
Bottom Width	feet	100	44	44	100	44	80	44	49	44	XXXXXX
Type--Excavated Earth			XX	XX	XX	XX	XX	XX	XX	XX	
Type--Excavated Rock		XX									
Percent Chance of Use			1	1	1	1	1	1	1	1	XXXXXX
Ave. Curve No. - Cond. II		84	93	93	89	89	91	92	93	92	XXXXXX
Emergency Spillway Hydrograph											
Storm Rainfall (6 hr.)	inches	4.2	1.9	1.9	3.0	1.9	1.9	1.9	1.9	1.9	XXXXXX
Storm Runoff (Average)	inches	2.15	1.22	1.22	1.90	0.94	1.08	1.15	1.22	1.15	XXXXXX
Velocity of Flow (Vc) 2/	ft./sec.	8.8	0	0	5.7	0	0	0	0	0	XXXXXX
Discharge Rate 2/	c.f.s.	2,210	0	0	595	0	0	0	0	0	XXXXXX
Maximum W.S. Elevation 1/ 2/	feet	1,053.0	100.5	111.0	120.8	946.0	111.5	102.0	101.5	92.0	XXXXXX
Freeboard Hydrograph											
Storm Rainfall (6 hr.)	inches	10.2	3.0	3.0	5.0	3.0	3.0	3.0	3.0	3.0	XXXXXX
Storm Runoff (Average)	inches	7.16	2.26	2.26	3.77	1,90	2.07	2.16	2.26	2.16	XXXXXX
Velocity of Flow (Vc) 3/	ft./sec.	13.6	4.9	5.1	7.5	5.6	6.0	3.7	5.8	4.6	XXXXXX
Discharge Rate 3/	c.f.s.	8,535	175	193	1,400	260	550	70	325	140	XXXXXX
Maximum W.S. Elevation 1/ 3/	feet	1,058.7	101.9	112.5	122.0	947/7	113.5	102.8	103.4	93.2	XXXXXX
Principal Spillway											
Capacity-Water Surface @ Crest of Emergency Spillway	c.f.s.		20	24	32	20	100	7	32	17	XXXXXX
Capacity Equivalents											
Sediment Volume	inches	0.69	1.42	1.37	0.84	1.13	0.77	2.18	0.97	1.54	XXXXXX
Retarding Volume	inches		1.22	1.21	0.93	0.94	1.05	1.01	1.22	1.16	XXXXXX
Spillway Storage	inches	3.61	0.92	1.04	0.62	0.53	0.99	1.58	0.87	2.18	XXXXXX
Class of Structure		"c"	"a"	"a"	"b"	"a"	"a"	"a"	"a"	"a"	XXXXXX

1/ Elevations on assumed datum.

2/ No flow over spillway by routing except as shown.

3/ Maximum during passage of hydrograph.

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TABLE 4 - ANNUAL COST

Ferron Watershed, Utah

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost	Operation, Maintenance, and Replacement Cost	Total
Mill Site Reservoir and Dam	109,810	4,000	113,810
Basic Facilities	2,830	7,500	10,330
North Ditch Debris Basins Four Structures	7,175	475	7,650
South Ditch Debris Basins Four Structures	8,980	555	9,535
Irrigation System Improvements	12,685	10,050	22,735
Fish and Wildlife Water Resource Improvements	8,415	500	8,915
GRAND TOTAL	149,895	23,080	172,975

January 1965

1/ Installation cost based upon 1964 prices, amortized over 100 years at 3-1/8% interest. Replacement cost adjusted for long-term prices, reduced to present value, and amortized over 100 years at 3-1/8% interest. Operation and maintenance cost adjusted for long-term prices.

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Ferron Watershed, Utah

(Dollars) 1/

Item	Estimated Average Annual Damage : Without Project	With Project	Damage Reduction Benefit
Floodwater			
Structures - Farm and Home	$ 1,410	$ 140	$ 1,270
Road and Bridge Damage	2,290	170	2,120
Feed, Materials, Cleanup	2,205	45	2,160
Canals - Irrigation Facilities	3,740	255	3,485
Crop and Pasture Damage	6,450	590	5,860
Land Damage	4,950	330	4,620
Interruption to Irrigation Services	1,660	60	1,600
Subtotal	$22,705	$1,590	$21,115
Sediment			
Structures - Farm and Home	$ 830	$ 50	$ 780
Road and Bridge Damage	1,290	135	1,155
Feed, Materials, Cleanup	5,640	45	5,595
Canals - Irrigation Facilities	5,250	455	4,795
Crop and Pasture Damage	6,605	310	6,295
Land Damage	5,560	1,030	4,530
Interruption to Irrigation Services	3,880	50	3,830
Subtotal	$29,055	$2,075	$26,980
Indirect Damage	$ 4,330	$ 280	$ 4,050
Total	$56,090	$3,945	$52,145

January 1965

1/ Long-term prices and costs.

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Ferron Watershed, Utah

(Dollars) 1/

Evaluation Unit	AVERAGE ANNUAL BENEFITS						Average Annual Cost	Benefit-Cost Ratio
	Flood Prevention							
	Damage Reduction Benefits	Water Conservation Benefits	Primary Irrigation Benefits	Fish and Wildlife Benefits	Secondary Benefits	Total		
Mill Site Reservoir Dam and Basic Facilities	$19,060		$272,705	$47,745	$42,830	$382,340	$124,140	3.1:1.0
North Ditch Debris Basins								
Four Structures	10,120	$1,245			950	12,315	7,650	1.6:1.0
South Ditch Debris Basins								
Four Structures	17,600	2,195			1,375	21,170	9,535	2.2:1.0
Irrigation System Improvements			54,675		8,255	62,930	22,735	2.8:1.0
Fish and Wildlife Water Resource Improvements				28,050		28,050	8,915	3.1:1.0
GRAND TOTAL	$46,780 2/	$3,440	$327,380	$75,795	$53,410	$506,805	$172,975	2.9:1.0

January 1965

1/ Installation cost based on 1964 prices and amortized over 100 years @ 3-1/8% interest. Replacement costs adjusted to long-term costs and prices, reduced to present values, and amortized over 100 years @ 3-1/8% interest. Operation and maintenance costs and benefits adjusted to long-term values.

2/ In addition to $5,365 downstream damage reduction from upper watershed land treatment.

TABLE 7 - CONSTRUCTION UNITS

Ferron Watershed, Utah

(Dollars) 1/

Measures in Construction Units	Annual Benefits	Annual Cost
North Ditch Debris Basins		
Four Structures	$ 12,315	$ 7,650
South Ditch Debris Basins		
Four Structures	21,170	9,535
Mill Site Reservoir and Dam	359,820	113,810
Irrigation System Improvement	62,930	22,735
Recreation Facilities	22,520	10,330
Duck Fork and Willow Lakes Fisheries	28,050	8,915

January 1965

1/ Long-term prices and costs for costs and benefits accruing in the future. Installation costs based on current (1964) prices.

PROJECT FORMULATION

Each watershed problem was clearly defined through discussion with the local sponsors and through investigation. Investigations were planned jointly by the participating agencies and carried out to determine feasible solutions to the problems and the effects of the land treatment and structural program.

The sponsors and participating agencies determined areas requiring accelerated land treatment measures. The land administering agencies outlined land treatment measures on federal land. The Soil Conservation Service, sponsors, and ranchers outlined the treatment program for private and state land. The sponsors and participating agencies formulated the land treatment program from proposals developed. The Soil Conservation Service and sponsors jointly investigated alternative proposals for structural treatment and formulated the program.

Land Treatment Measures

Land treatment measures were outlined where investigations showed a need for treatment. The going program is based upon a projection of current application rates with adjustments to reflect trend. The accelerated program is based upon needed accelerations of the going program adjusted to the application rate expected with the project.

Structural Measures

Areas of the watershed experiencing significant flood and sediment damage were determined by a map reconnaissance of the watershed with the sponsors. Reconnaissance surveys were made in the field to determine the magnitude of the flood problems where local sponsors and historical information indicated flood damage. Damage surveys were made for each independent drainage where reconnaissance surveys indicated a need. The kinds, frequency, and extent of damage from historic floods were thus established. This flood damage information served as the basis for calculating present annual damage and made up the base from which projected future damage reductions could be estimated.

Alternative measures including the multipurpose Mill Site Reservoir were outlined where reconnaissance surveys indicated a need for flood prevention structures. Engineering, hydraulic, hydrologic, and economic investigations and data required to plan these measures and define their effect on flood problems were determined. Available information and data pertinent to the proposed structures were collected from the files of the Soil Conservation Service and other federal, state, and local agencies. Needed additional surveys and investigations were planned and carried out.

A water measurement program was carried out during the 1962 and 1963 irrigation seasons on representative sections of canals and laterals serving two or more irrigators. Measurements were made at selected locations with the Falling Head Seepage Meter during the 1963 irrigation season. This information was the basis for determining conveyance efficiency of the irrigation distribution system and selection of canal sections needing lining.

A sample farm inventory was conducted, including 14 irrigated farms--about 10% of the irrigated area. This data served as the basis for defining the principal irrigation problems and for evaluating present conditions.

Water requirements were determined by month and one-half month periods at the Ferron Creek stream gage for the irrigated area based upon soils, cropping pattern, on-farm irrigation efficiencies and conveyance efficiencies under present conditions and with each increment of the proposed program. This data provided information needed to evaluate water conservation benefits from system improvements and for reservoir operations studies.

The active capacity of the multipurpose Mill Site Reservoir was determined by reservoir operations studies utilizing 30 years of streamflow record for the Ferron drainage. The active capacity was designed to regulate the waters of Ferron Creek to coincide as nearly as practical with the requirements of the irrigated crops. Summer floods come at a time when water has been drawn down and reservoir capacity is available to accommodate the flood volume. Downstream channels will accommodate snowmelt runoff in excess of reservoir capacity after removal of sediment and debris, and reduction in duration and volume of flow through storage. The reservoir operation, based upon runoff forecasts, will enable control of snowmelt floods above the 20% chance frequency annual yield. The sediment capacity required to store sediment accumulation expected over the next 100 years was designed to eliminate downstream sediment damage. Fish and wildlife capacity in the Mill Site Reservoir was selected to provide a suitable trout fishery. The recreation facilities, kinds and amounts, are based upon expected use. The expected use was determined by analysis of use records and secondary data concerning similar areas in the state adjusted to local conditions.

Use records of small reservoirs in a setting similar to the Duck Fork and Willow Lakes reservoirs were collected and evaluated. These data were used to determine the need for water resource improvements in higher elevations of the watershed. The reservoirs--area, depth, and volume--were designed to carry fish through the winter and to provide a suitable resource.

Alternative Structural Measures Considered

Four dam sites in the vicinity of the Mill Site, off-channel storage sites, and a system of reservoirs in the upstream drainage pattern were considered as alternative proposals to the multipurpose Mill Site Reservoir and Dam. Preliminary designs and cost estimates were made for each of the structures considered feasible. The Mill Site was selected on the basis of relative cost and because for physical reasons it would most nearly meet project requirements.

Several alternate debris basin sites were considered on each drainage. The best site was selected based upon apparent differences in cost and optimum effectiveness.

Diversion dikes and overshots were considered as alternatives to the debris basins above the canals. These structures were eliminated from consideration because of high cost and because they would shift the flood problem to another location downstream.

Structural measures for improvement of irrigation systems have been selected over the years from possible alternatives and included in group irrigation plans. Each of the proposals included in the plans were examined from a benefit-cost standpoint and reviewed with the sponsors. The sponsors selected the structural measures for improvement to their system after reviewing the effects on the operation of their system, as well as the benefits and costs.

Numerous reservoir sites, small existing reservoirs, and natural lakes in the upper watershed were examined for water resource improvements for fish and wildlife. The Willow Lakes and Duck Fork sites were selected because they will best serve project objectives with the least cost.

SOILS

The soils inventory and land capability information for private and state land was obtained from existing Soil Conservation Service records. Soils were given Management Capability class ratings on the basis of slope, physical characteristics of the soil, and climatic conditions. Soils information for the federal land was obtained from the files of the land administering agencies.

RANGE

Federal Range Land

Investigations and studies on federal range land were conducted by the responsible land administering agency. Vegetative and soil resources, type and extent of erosion, areas producing floodwater and sediment (critical areas), range conditions and trends were established and range sites identified. Land treatment measures needed to stabilize critical areas, arrest land deterioration, and provide a balance between forage production and grazing were outlined. Technicians of the land administering agencies worked closely with the Soil Conservation Service in selecting feasible measures.

Private and State Range Land

Private and state range areas were classified into range sites. These sites were further classified as to their present and potential condition, plant composition and density, and forage production. In general, the private and state range land soils are derived from shales, have a low water intake rate, are subject to accelerated erosion and support a sparse, semi-desert type vegetation because of soil and moisture deficiencies. These range lands are interspersed with the Bureau of Land Management lands and among the irrigated lands, and are grazed in conjunction with these areas. Feasible treatment measures are incident to management and include short sections of fence, a few stockwater ponds, proper use, and distribution of livestock.

GEOLOGY

Mill Site Storage Reservoir

Foundation Investigations

Investigations consisted of core drilling, permeability testing, seismograph surveying, and test pit excavations. Soil samples were collected and classified by laboratory analysis and visual inspection. The soils are described as sandy silts, silty sands and gravels, well graded gravels, and sandy silty clays of low plasticity. Laboratory tests and analyses consisted of triaxial shear, permeability, dissolvable solids, atterberg limits, and grain size distribution.

The soil materials in the foundation and in the borrow areas consist of recent floodplain deposits, colluvial and residual deposits, and older terrace deposits. The floodplain and terrace deposits are highly stratified, moderate to highly permeable, slightly saline, loose and dry. The colluvial and residual deposits are moderately to slowly permeable, slightly compact, moderately saline, and moist to dry. The soil materials were all derived from sedimentary rocks--mainly sandstones, limestones, and shales.

The bedrock in the abutments consists of irregular-bedded, massive to thin-bedded, calcareous, silty sandstones. These rocks contain some soluble salts and are slightly weathered and fractured at the surface.

The proposed structure is in site group I and will have capacity to store the expected 100-year sediment yield. The dam will be a zoned fill structure with an upstream blanket and a partial cutoff core to prevent possible dam failure and excessive water losses. The spillway will be excavated in sandstone rock and will have a concrete control section. The outlet end of the spillway channel will be protected with concrete to prevent erosion and undercutting at the overpour.

Investigations and studies of site conditions indicate that the dam can be constructed as planned. However, before final designs are completed, additional subsurface investigations will be made to more accurately determine the character and extent of the materials in the foundation, abutments and emergency spillway. The proposed borrow areas will be outlined in detail and additional samples will be obtained for testing.

Fish and Wildlife Structures

Foundation Investigations

Investigations consisted of core drilling, permeability testing, and test pit excavations at the Duck Fork Reservoir. Surficial examinations and auger borings were made at Willow Lakes. Soil samples were collected and the materials were classified by laboratory analysis and visual inspection. The soils are described as silty gravels, clayey sands and gravels, poorly graded gravels and sands, and silty clays of low to high plasticity. Some peat materials were found at the Duck Fork Reservoir in the dam foundation below the downstream toe of the dam. However, these materials are not extensive and they present no

particular problem. Laboratory tests and analyses of samples obtained at the Duck Fork dam included triaxial shear, compaction, permeability, consolidation, dissolvable solids, atterberg limits, and grain size distribution.

The soil materials in the area were derived from sedimentary rocks--mainly shales, sandstones, and limestones. Soil materials at the Duck Fork Reservoir consist of glacial deposits and colluvium. Soil materials at the Willow Lakes consist of landslide deposits and colluvium.

The Duck Fork Reservoir dam is in site group I. The dam is a homogeneous fill with 3:1 upstream and 2:1 downstream slopes. The reservoir was not used for irrigation storage in 1964 because of erosion in the earth spillway, which occurred in 1963. Repairs planned for this structure consist of an upstream cutoff trench, a foundation drain, additional riprap protection on the face of the dam, and relocation of the earth spillway outlet channel. A riser will be installed on the existing outlet pipe and the water level will be stabilized 8 feet below the present earth spillway crest.

The Willow Lakes Reservoir dam is in site group II. The existing dam is a homogeneous fill with 3:1 upstream and 2:1 downstream slopes. Renovation and enlargement of this structure will consist of raising the dam 5 feet and installing a cutoff trench at the upstream toe of the dam. A riser will be installed and a permanent pool will be established at an elevation 5 feet above the present high water level.

Studies and investigations of site conditions indicate that these dams can be constructed as planned. However, before final designs are completed, additional investigations will be made to accurately determine the subsurface conditions at the Willow Lakes and the exact location of the emergency spillway will be determined. The proposed borrow areas will be outlined in detail and samples will be obtained for laboratory analysis and testing.

Debris Basins

Foundation Investigations

Investigations consisted of auger borings and surficial examinations. Soil samples were collected and classified by visual inspection and limited testing. The soils are described as silty sands and gravels, well graded and poorly graded gravels, sandy silts, and silty clays of low plasticity.

The soil materials in the foundation and borrow areas consist of floodplain and alluvial fan deposits, colluvial and residual deposits, and terrace deposits. The floodplain, alluvial fan and terrace deposits are highly stratified, moderate to highly permeable, slightly saline, loose and dry. The colluvial and residual deposits are moderate to slowly permeable, slightly compact, moderately saline, and dry.

Most of the sites have bedrock abutments consisting of sandstone, siltstone, and mudstone. All of these rocks contain some soluble salts.

Structure data for the proposed flood control sites follows:

Structure Site	Site Group	Structure Class	Height of Fill	Type of Fill
1. Straight Hollow - S.	II	a	23	Homogeneous
2. Straight Hollow - N.	II	a	23	Homogeneous
3. Herring Flat-Zwahlen Wash	II	a	17	Homogeneous
4. Diversion Hollow	II	a	11	Homogeneous
5. Indian Hollow	I	b	22	Zoned
6. Eli Hollow	II	a	18	Homogeneous
7. Jewkes Hollow	II	a	23	Homogeneous
8. Dutch Flats	II	a	18	Homogeneous

All of the proposed dams except Diversion Hollow are designed with a cutoff trench to reduce the danger of piping. The Diversion Hollow dam will have an upstream blanket to prevent piping and possible failure of the dam. The emergency spillways will be excavated in alluvium or rather soft bedrock which will be quite easily eroded. The structures will have sufficient capacity to store the expected 100-year sediment yield.

Studies already made indicate that these dams can be constructed as planned. However, before final designs are completed, subsurface investigations will be made at each site to accurately determine the character of the materials in the foundation, abutments, and emergency spillways. The proposed borrow areas will be outlined in detail and samples will be obtained for testing.

SEDIMENTATION

Sediment investigations have been made in the general area by other government agencies. The U. S. Geological Survey has published sedimentation data for the small reservoirs located in the San Rafael Swell and the U. S. Bureau of Reclamation has made studies on Cottonwood Creek, an adjacent drainage to the north. Sediment investigations and analyses made to develop this plan consisted of:

1. Sampling suspended load material in Ferron Creek during the 1963 water year.
2. Measuring pond, reservoir, and fan deposits in the Ferron Watershed.
3. Measuring gully voids in the upper watershed area.
4. Transposing sediment rates from adjacent, similar watersheds.

5. Studying plant cover-condition and soils inventory data.

6. Mapping sediment and erosion damages in the lower watershed area.

Sediment concentration (by weight) varied from 0.1 to 40.0% in Ferron Creek during the summer cloudburst storm period--July and August. The sediment concentration during the snowmelt runoff period ranged from 0.1 to 2.3%. Sediment rates could not be predicted from the suspended load measurements because of the short period of record.

A reconnaissance survey was made of the Duck Fork Reservoir to determine sediment rates in the upper watershed area. Alluvial fan deposits and deposits in an old stock pond were measured in the lower watershed to determine sediment rates for areas of Mancos shale. These measurements plus measurements of gully voids in the intermediate area of the watershed provided most of the data used to calculate sediment rates at the proposed Mill Site Reservoir. Sediment rates for the debris basin sites were computed by supplementing these data with information available from other watersheds having similar soils, geology, and cover.

Reductions in sediment rates are based on studied watersheds and estimated future watershed conditions as indicated by the plant cover-condition and soils inventory. A reduction of 20% was assumed after a period of 20 years.

Some cropland and pasture land has been destroyed by gully voiding. The cropland soils are quite unstable and are susceptible to piping. Headcutting and bankcutting are active in most of the tributaries which drain the agricultural lands. Based on samples of gully voiding mapped within the cropland and pasture land area, land losses are as follows:

Land Use	Land Loss During Last 50 Years (Acres)	Estimated Land Loss During Next 50 Years (Acres)	Reduction Due to Watershed Treatment (Percent)
Cropland	242	141	42
Pasture Land	79	50	37
Total	321	191	

Sediments damage lands, crops, irrigation systems, roads, fences, and many other improvements and watershed resources. Deposition on the irrigated land causes surface irregularity and increases the need for leveling. Some irrigated lands are also damaged by swamping because sediment deposits restrict natural drainage channels and outlets.

The volume of sediment depositing on irrigated lands and in irrigation systems was obtained by estimating a percentage of the total sediment yield. In order to evaluate land damage caused by surface irregularity, an estimate was made of the amount of sediment which would need to be moved during land leveling operations.

The sediment volume associated with the various flood events was obtained by plotting a sediment-frequency curve parallel to the peak flow-frequency curve. The position of the sediment-frequency curve was adjusted so that the total volume delivered from all flood events equalled the 50-year sediment yield determined from measurements. The sediment volume in each storm frequency was added to the floodwater volume to estimate inundation damages and damage to irrigation facilities.

Erosion is severe on the lower portions of the watershed because of steep topography, bare to sparsely vegetated slopes, and rather unstable soils. The Mancos shale formation crops out on about 20 percent of the lower foothill area. This sandy, silty material produces soils which are rather unfertile because of their high salt content and low infiltration capacity. Sheet and gully erosion in the lower portion of the watershed produces about 50 percent of the total sediment yield. The sparse plant cover in the foothill area consists mainly of pinon-juniper, brush and annual weeds.

Erosion is moderate to severe at the intermediate elevations because of variable soil conditions and topography. High erosion rates exist in some areas because of bare shaly exposures; steep slopes; loose, moderately deep soils; and sparse vegetative cover. Other areas have moderate erosion rates because of resistant sandstone outcrops, gentle slopes, shallow soils, and fair vegetative cover. The main plant cover types are pinon-juniper, brush, and grass.

The upper watershed area has low to moderate erosion rates because of fair vegetative cover, cohesive soils, and moderate slopes. Many small, closed basins exist because of extensive areas of glacial and landslide topography. The principal plant cover types are pine, spruce, fir, quaking aspen, grass, and brush.

Ferron Creek and Rock Canyon are the only drainages which yield significant quantities of sediment during the snowmelt runoff period. Part of the sediment deposited in Ferron Creek channel by the summer storms is picked up by the snowmelt runoff and transported to the damage area. Most of the small drainages flow only during the summer cloudburst type storms.

Sediment data for the proposed structures follows:

Proposed Site	Drainage Area - sq. mi.	Computed 100-Yr. Sediment Yield-Ac.Ft.	Est. Deposition above crest Level - Percent	Est. Trap Efficiency - Percent	Sediment Capacity Required Below Crest Level - Ac.Ft.
Mill Site Reservoir	157.20	7,237	20	95	5,800
Straight Hollow South	2.10	161	20	85	109
Straight Hollow North	.44	81	20	90	58
Herring Flat-Zwahlen Wash	5.20	355	30	90	223
Diversion Hollow	1.29	130	30	85	78
Indian Hollow	2.18	165	30	85	98
Eli Hollow	1.38	134	20	95	102
Jewkes Hollow	1.19	126	20	90	91
Dutch Flats	1.04	120	20	85	82

ENGINEERING

Multipurpose Structure

Mill Site Reservoir and Dam

Surveys and investigations of record for this site date back to 1933. Several alternative dam sites were considered, all within the vicinity of the dam site selected. Existing information and data concerning previous investigations, surveys, and designs were gathered and reviewed.

A detailed topographic map covering most of the reservoir area and fifteen minute U.S.G.S. topographic maps of the vicinity were the basis for the storage curve. Detailed topographic maps were made covering the alternative embankment sites and spillway locations. Foundation and borrow investigations detailed under "Geology" were carried out to establish a base for design of the structure. Preliminary designs and cost estimates were completed for each alternative embankment site. The Mill Dam Site was selected because it is best from the physical standpoint and can likely be constructed at the least cost.

Designs for this earth fill structure were developed using a detailed topographic map of the site, results of soil materials tests, and standard design procedure outlined in the U. S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook. A description of the structure may be found under "Works of Improvement to be Installed." Preliminary plans are shown on Figures 3 and 4. Capacity, size, etc., are shown on Table 3.

The emergency spillway cut in rock, bottom width 100 feet, 1:1 slopes, and length of 1,000 feet, is designed to pass the design hydrographs for the site as detailed under "Hydrology." It will remain stable under prolonged snowmelt runoff conditions. The alluvium which fills the valley to be used for the exit channel will be excavated to bedrock for fill. The lateral stream channel is already on bedrock for a distance above its confluence with Ferron Creek and prominent rock ledges are uncovered at intervals up the valley. Available fill material will also be excavated from the area of the plunge pool. Large boulders on the surface and throughout the alluvial fill will serve to line the plunge pool.

Preliminary investigations and soil materials testing indicate that this dam can be constructed without difficulty from foundation or construction materials standpoint. Fill materials will need to be selected carefully and is available in the vicinity of the site. Intensive foundation, borrow investigations, and testing should be completed and a complete topographic map made before construction designs are initiated.

Recreation facilities were planned with the assistance of recreation specialists after a complete reconnaissance of the site. A schematic layout, including number and kinds of facilities, was made on photographic enlargements of the site. Standard designs and costs were utilized where applicable. The preliminary plan shown on Figure 5 provides for the recreation facilities considered necessary to meet current demands with provisions for expansion. The local sponsors have reviewed the plans on the site, together with cost, cost sharing, operation, maintenance, and replacement responsibilities.

Before construction plans are developed for the recreation facilities, a detailed topographic map showing existing plants and physical features will be needed.

Single Purpose Structures

Debris Basins

Alternative sites for debris basins were selected after reconnaissance of the watershed. Preliminary designs and cost estimates were based upon fifteen minute U.S.G.S. topographic maps, level observations on the site, and detailed surveys available in local files. Selection of alternatives included in the plan were based upon preliminary costs and relative effectiveness of the structures in solving watershed problems.

Topographic surveys were either available or made for six of the alternative sites selected. Profile surveys and level observations were made for the other sites where uniform gentle topography prevails. Work plan designs and costs were based upon these surveys.

Principal features of the debris basins are illustrated on the typical plan, Figure 2. Descriptions may be found under "Works of Improvement to be Installed." Size, capacity, etc., are outlined in Table 3.

Generally, each debris basin will consist of a low earth embankment, principal spillway, and earth emergency spillway. Each earth fill will be provided with a cutoff according to the requirements of the site. It will be necessary to blanket the front face of the Diversion Hollow embankment because of the scarcity of fine fill material and the configuration of the site. Each principal spillway will consist of a restricted flow riser and pipe outlet conduit. The outflow of each principal spillway will be limited to the capacity of downstream channels.

Temporary storage is provided in each debris basin to accommodate the 100-year frequency flood runoff. The emergency spillways are designed in accordance with Engineering Memo SCS-31 and Technical Release No. 2, Supplement A, "Earth Spillways." The emergency spillway hydrographs for the seven class "a" structures will pass through the principal spillways with water surface elevations below the crests of the emergency spillways. The emergency spillway for the class "b" structure will accommodate the emergency spillway hydrograph at a safe velocity for the site. Each spillway is proportioned to pass the freeboard hydrograph with water surface elevation at or below the settled height of the dam.

Investigations indicate no particular difficulty in final design or construction. Salt content of the fill material should be checked carefully and if found detrimental to concrete, either specially designed concrete or corrugated metal should be used for the principal spillways.

Water Resource Improvements for Fish and Wildlife

Suitable alternative sites included existing irrigation reservoirs, pot holes in landslide topography, and virgin sites on the drainages. Available topographic maps were collected and needed additional surveys and investigations were planned and carried out. Preliminary designs and estimated costs were developed for each site. The best sites were selected based upon a comparison of construction cost and relative value of each site as a fishery. Preliminary plans for these structures are shown on Figures 7 and 8.

Each structure is designed with a principal spillway, crest elevation at permanent pool level, and an emergency spillway. Each principal spillway consists of an outlet pipe conduit with pipe riser or equal. The outlet pipe is provided with a stilling basin. The riser will be equipped with antivortex device or fish screen, with appurtenant drainage gate and up-the-slope control. The emergency and freeboard hydrographs, class "b" criteria, and the 100-year frequency snowmelt inflow will pass through surcharge storage and principal spillway with water surface below the crest of the emergency spillway. The emergency spillways were proportioned in accordance with criteria outlined in Engineering Memorandum SCS-31 and Technical Release No. 2, Supplement A, "Earth Spillways."

To provide the required permanent pool at the Willow Lakes, it will be necessary to raise the existing fill by 5.0 feet, install a cutoff, a principal spillway, an emergency spillway, and riprap the front slope of the dam. A channel spillway located near the south end of the present dam should be considered in the design stage as an alternate to the location shown on the preliminary plan.

The existing Ferron-Mayfield road is routed over a short section of fill by the northern edge of the Willow Lakes. The present fill and road will be raised by approximately five feet, lengthening this section of road over fill to about 1,200 feet. This will provide for replacement road about equal to the existing facility.

Three hundred feet of log and block fence must be moved and reconstructed near the southeast end of the proposed fill.

The requirements for the permanent pool at the Duck Fork site will enable the crest of the principal spillway to be set some 8 feet below the crest of the existing earth spillway. This principal spillway will consist of a 48-inch pipe or equal affixed to a 24-inch existing outlet conduit. Recent erosion in the earth spillway has uncovered lenticular lake deposits near the downstream toe of the dam which may affect the stability of the fill. The maximum height of the dam is 40 feet. To render the dam stable, a rock toe drain with a gravity drain and a cutoff will be needed. The riprap on the front slope is thin in spots and will need reinforcement. The existing fill is otherwise adequate.

The existing emergency earth spillway will need extensive reorganization. The crest will be approximately at the same elevation and location. A straight exit channel will be excavated and the old exit channel filled. The emergency spillway will be protected with grouted rock and riprap as required.

Irrigation System Improvements

Conservation plans for the irrigation company and informal groups and engineering plans for specific structures have been developed with the irrigation companies and individuals cooperating with the San Rafael Soil Conservation District. Additional field surveys were made and designs and cost estimates adjusted to reflect current construction technique, material, procedure, and cost. Designs and costs were also made for alternative proposals.

Improvements included in the work plan were selected after a careful study of water conservation benefits and reductions in operation and maintenance costs. Designs for measures included in the plan are based upon standard procedures of the Soil Conservation Service used in the local Soil Conservation District program.

Land Treatment Measures

The going program of the San Rafael Soil Conservation District was analyzed to determine the accelerated land treatment program needed. Engineering phases included the determination of size, extent, and unit cost of treatment measures.

Costs

Preliminary designs and cost estimates were prepared for alternative structural measures. The most economical designs and measures were selected which most nearly meet the requirements of the project. Quantities of construction material were computed for the structures selected.

Estimated costs were based upon construction quantities and unit costs. Unit costs were taken from bid item schedules for work recently completed under contract in the vicinity modified by differences in site conditions. These differences include location, topography, geologic characteristics, size of construction bid items, and availability and accessibility of materials.

Designs and cost estimates for the water resource improvements for fish and wildlife were prepared by the Soil Conservation Service and the Utah State Department of Fish and Game. The Forest Service has reviewed the plans and site locations for the fisheries on the National Forest and has concurred in the preliminary designs.

Estimated costs--construction and other--to be provided by the Utah State Department of Fish and Game for fish and wildlife are detailed below.

1. Construction Cost	
Willow Lakes	$ 34,000
Duck Fork	27,600
Mill Site Reservoir (Fish and Wildlife pool)	140,800
Subtotal	$202,400
2. Water and Storage Rights for Duck Fork, Ferron, and Willow Lakes	$100,000
3. Contract Administration Cost	$ 2,000
4. Land, Easement, and Rights-of-way Cost	
Obtain Special-Use Permits	$ 400
Replace Log and Block Fence at Willow Lakes	300
Subtotal Other	$102,700
Total Project Cost	$305,100
5. Non-Project Cost (at Ferron Reservoir)	9,500
GRAND TOTAL, ESTIMATED FISH AND GAME COST	$314,600

Cost Allocation and Cost Sharing

Installation costs for structural measures included in this plan are allocated to the purpose(s) served by each measure. Cost allocated to each purpose is shared between P.L. 566 and other funds in accordance with Public Law 566 as amended and the Policy Statement of the Secretary of Agriculture.

Mill Site Reservoir and Dam:

This structure serves the purposes of flood prevention, irrigation, and fish and wildlife development. Installation costs for the reservoir and dam are allocated to the purposes served by the use of facilities method. Land, easements, and rights-of-way costs eligible for cost sharing are allocated to fish and wildlife development. Remaining land, easements, and rights-of-way cost are allocated between flood prevention and irrigation as determined by the use of facilities method.

1. Allocation of Cost

   A. Determination of land, easements, and rights-of-way cost eligible for cost sharing

The total land required for the reservoir and recreation facilities is 638 acres--570 acres for the reservoir and dam, 18 acres for relocation of the road, and 50 acres for the recreation facilities. This acreage includes 240 acres of federal land administered by the Bureau of Land Management, 28 acres of non-federal public land, and 370 acres of private land.

The non-federal public land, to be donated, and the federal land can be acquired with only legal and survey costs. To acquire the 370 acres of private land required, one farm ownership consisting of 620 acres must be purchased. The irrigated land and farmstead which make up the principal value of the ownership are included in the 370 acres. The remaining 250 acres are made up of steep escarpments and side hills and have little value.

Three miles of road relocation are required for the reservoir and dam.

(1) Estimated Costs

Eligible for Cost Sharing

Cost for 370 acres of private land	$25,000
Construction cost - 3.0 miles of road relocation	18,000
	$43,000

Not Eligible for Cost Sharing

Value lands to be donated	$ 9,000
Cost 250 acres private land	1,000
Legal, survey and other costs (includes all land rights costs for recreation facilities)	1,000
	$11,000
Total Estimated Cost	$54,000

(2) Cost Eligible for Cost Sharing

Total area required for the dam and reservoir	570 acres
Area of fish and wildlife pool	236 acres
Area of irrigation pool	420 acres
Area for purposes other than fish and wildlife (420 - 236)	184 acres

$\frac{570-184}{570}$ = 67.7% of required land and road relocation cost eligible for cost sharing.

67.7% X 43,000 = $29,000 land, easements, and rights-of-way cost eligible for 50-50 cost sharing.

54,000 - 29,000 = $25,000 ineligible for cost sharing.

B. Basis for Allocation of Construction Cost for Reservoir Dam

Capacity

Sediment Capacity	5,800 A.F.
Fishery	2,000 A.F.
Irrigation	10,200 A.F.
Total	18,000 A.F.

Initially, the permanent pool will be set at 2,500 A.F. which will provide the desired fishery volume plus the expected sediment deposition in that pool during the first 10 years of operation. Thereafter, the level of the irrigation outlet will be raised every 10 years to provide the sediment capacity to be required during the following 10 years, approximately 470 acre feet. The remaining capacity of the reservoir will be used jointly for sediment storage and irrigation storage regulation. The basis for allocation of costs follows:

	Capacity by Purpose			
Storage	Total Capacity	Flood Prevention	Fish and Wildlife Development	Irrigation
	A.F.	A.F.	A.F.	A.F.
For Fishery	2,000		2,000	
For Sediment	500	500		
Joint Sediment and Irrigation	5,300	2,650		2,650
For Irrigation	10,200			10,200
Total Storage	18,000	3,150	2,000	12,850
Percentage	100%	17.5%	11.1%	71.4%

C. Cost Allocation, All Costs

		Allocated Costs - Dollars		
Item	Total Cost	Flood Prevention	Fish and Wildlife Development	Irrigation
Construction Cost				
Joint Cost	$2,536,000	$443,800	$281,600	$1,810,600
Specific Cost (Irrigation Outlet)[3/]	64,000			64,000
Installation Services	650,000	113,800	72,100	464,100
Lands, Easements, and R/W	54,000	4,900[2/]	29,000[1/]	20,100[2/]
Contract Administration	48,000	8,400	5,300	34,300
Total Installation Cost	$3,352,000	$570,900	$388,000	$2,393,100

1/ Land, easements, and rights-of-way cost eligible for cost sharing.
2/ Land, easements, and rights-of-way cost ineligible for cost sharing assigned to flood prevention and irrigation on basis of relative capacities.
3/ Construction cost for dry man well access shaft, control gates, and associated appurtenances.

2. Cost Sharing Summary

	P.L. 566	Other	Total
Construction Cost			
(Joint)	$1,489,900	$1,046,100	$2,536,000
(Specific-Irrigation Outlet) 3/	32,000	32,000	64,000
Installation Services	650,000		650,000
Lands, Easements, and R/W	14,500	39,500	54,000
Contract Administration		48,000	48,000
Total Installation Cost	$2,186,400	$1,165,600	$3,352,000

3/ Construction cost for dry man well access shaft, control gates, and associated appurtenances.

Recreation Facilities:

These facilities will be installed adjacent to the Mill Site Reservoir. The installation costs are allocated to fish and wildlife development.

Cost Sharing:

	P.L. 566	Local	Total
Construction Cost	$33,400	$33,400	$66,800
Architectural and Other Engineering Services 1/	8,300	8,300	16,600
Contract Administration		3,000	3,000
Total Installation Cost	$41,700	$44,700	$86,400

1/ The local sponsoring organization doesn't have an engineering or architectural staff.

Note: The facilities are to be installed on federal land administered by the Bureau of Land Management. Legal, survey, and other costs associated with acquiring rights are included in cost for the Mill Site Reservoir.

Debris Basins:

Installation costs for these eight single purpose structures are allocated to flood prevention. Cost sharing follows:

	P.L. 566	Other	Total
Construction Cost	$382,700		$382,700
Installation Services	95,900		95,900
Other Costs		$14,500	14,500
Total Installation Cost	$478,600	$14,500	$493,100

System Improvements:

Installation costs for these single purpose irrigation structures are allocated to irrigation. Cost sharing follows:

	P.L. 566	Other	Total
Construction Cost	$143,000	$143,000	$286,000
Installation Services	71,600		71,600
Other Costs		29,600	29,600
Total Installation Cost	$214,600	$172,600	$387,200

Fish and Wildlife Water Resource Improvements:

Installation costs for the Willow Lakes and Duck Fork fisheries are allocated to fish and wildlife. Cost sharing follows:

	P.L. 566	Other	Total
Construction Cost	$61,600	$61,600	$123,200
Installation Services	30,900		30,900
Water Rights		100,000	100,000
Other Costs		2,700	2,700
Total Installation Cost	$92,500	$164,300	$256,800

HYDROLOGY

Hydrologic studies were primarily concerned with (1) determining the present and future peak flow-runoff series for use in developing area-inundated frequency relationships, (2) evaluating the effects of the land treatment measures, (3) computing volume-duration-frequency relationships for design of debris basins and the Mill Site Reservoir, (4) computing emergency spillway design hydrographs and flood routings for structural design, and (5) making a frequency analysis of the yield of Ferron Creek.

Other investigations concerning hydrology are detailed under the section entitled "Irrigation Investigations."

Basic Data Available

Climatological Data

The one U. S. Weather Bureau Station (elevation 5,925) in the watershed is located 0.5 mile south of the Ferron Post Office. This station has 19 years of temperature and precipitation records.

The rain gage is a standard non-recording type and temperature is read from a maximum-minimum thermometer. In addition, a class A evaporation pan was maintained from March 1948 till December 1950.

The three snow courses in the watershed have records dating back to 1955 and 1956. These courses are located on the western edge of the watershed at elevations of 9,000 to 9,800 feet. The course at Buck Flat has storage-gage precipitation data available.

Rainfall intensity frequency values, available from Weather Bureau Technical Paper No. 40 (May 1961), were increased to the amounts shown below to better reflect records of past storm events.

Frequency of Occurrence - Yrs.	100	50	25	10	5	2
Point Rainfall (short-duration) - In.	1.9	1.7	1.5	1.2	1.0	.71

Streamflow Data

There are several U. S. Geological Survey streamgaging stations on the San Rafael River and its tributaries. These discharge records, the earliest of which began in 1909, were analyzed as the basis for project surface water supply.

Local Flood Reports

Newspaper accounts and pictures, Soil Conservation Service flood reports, reports of the U. S. Forest Service, Weather Bureau, and Geological Survey concerning severe local storms and damaging flood runoff were available and used. Field reconnaissance surveys were made to outline the problem areas.

Hydrologic Condition Data

The U. S. Forest Service made detailed hydrologic condition surveys and analyses on the National Forest land. U. S. Bureau of Land Management Forage Inventory Field Writeup Sheets covering the principal areas of low elevation rangeland were available and used. Range site and condition surveys were made by the Soil Conservation Service on representative areas of the watershed as a supplement to this data.

Investigations

Watershed Hydrologic Conditions

Hydrologic conditions on National Forest land were determined from detailed field surveys and analyses by the U. S. Forest Service. Field reconnaissance and correlation with records of the Bureau of Land Management provided the basis for determining the hydrologic condition of rangeland outside the National Forest boundaries. Cooperative field studies between the Soil Conservation Service, Bureau of Land Management, U. S. Forest Service, and Utah State Department of Fish and Game were made to determine range condition and land treatment needs.

Field surveys of existing channels provided a basis for estimating time of concentration for use in computing peak rates of runoff.

Runoff curve numbers were assigned to each soil-cover complex, based on its land use and treatment, hydrologic condition, and soils data. An average antecedent moisture condition (II) was used in all runoff determinations.

Estimation of Volumes and Peak Rates of Runoff

A synthetic evaluation series of volumes and peak rates of runoff was developed for various frequencies for each drainage area where land treatment or structural measures were proposed. Runoff volumes were computed for modified rainfall amounts obtained from U. S. Weather Bureau T. P. 40 (see rainfall tabulation under "Climatological Data") and runoff curve numbers developed for the area. The procedure followed is described in Parts 3.7, 3.8, 3.9, 3.10, 3.15, and 3.16 of Supplement A, Section 4, Soil Conservation Service, National Engineering Handbook.

Peak rates of runoff were computed using procedures established from data obtained from Agricultural Research Service experimental watersheds located in the southwestern United States and methods described in Part 3.16 of Supplement A, Section 4, Soil Conservation Service, National Engineering Handbook.

Evaluation of Land Treatment

The reduction between the estimated runoff under present conditions and future conditions with proper range use was the basis for evaluation of the management practices. The reduction between the estimated runoff under future conditions with proper range use and with proper use plus mechanical treatment measures was the basis for evaluation of the mechanical treatment measures.

Hydrologic Design

Floodwater storage capacity provided in each debris basin is in accordance with Engineering Memorandum SCS-27 and Technical Release No. 10.

Design hydrographs for all debris basins and reservoirs were developed in accordance with Soil Conservation Service standards set forth in Engineering Memorandum SCS-27 and in Part 3.21 of Supplement A, Section 4, Soil Conservation Service, National Engineering Handbook.

The Mill Site Reservoir is a class "c" structure. Seven of the debris basins are class "a" structures and one is class "b". The water resource improvements for fish and wildlife are class "a" structures.

To insure infrequent operation of emergency spillways, floodwater storage capacity is provided in each debris basin to contain the 100-year frequency multiday storm runoff volume as outlined in Technical Release No. 10.

Rainfall depths used to develop the Emergency and Freeboard hydrographs are from maps accompanying Advisory Notice W-2018.

Routing of the Emergency and Freeboard hydrographs, by the storage indication method, beginning at the crest of the emergency spillway, is the basis for design proportions of the emergency spillway and selection of the settled height of dam for the Mill Site Reservoir Dam. Selection of emergency spillway dimensions and the settled height of dam for each debris basin was based upon Engineering Memorandum SCS-31. The spillway design hydrographs for each debris basin were routed by the improved coefficient method with routing beginning at the top of the level sediment pool.

The emergency spillway proportions and the settled height of dam for each fishery was based upon Engineering Memorandum SCS-31. Surcharge storage between the crest of the principal spillway and the emergency spillway was carefully selected to store the Emergency and Freeboard hydrographs (developed by "b" criteria) and to store and pass the 100-year frequency snowmelt inflow without operation of the emergency spillway. This conservative hydrologic design will ensure that the earth spillways for these structures located high in the National Forest will not operate except under very extreme runoff conditions.

A detailed reservoir operations study of the Mill Site Reservoir, with inflow modified to take into account the past operation of Ferron, Willow Lakes, and Duck Fork reservoirs, was used to determine the effects of the reservoir on both snowmelt and summer flood peaks and volumes as well as on water supply for the irrigated fields.

Reservoir operations studies, based upon runoff forecasting, were also used to determine the effect of the Mill Site Reservoir on the larger, less frequent snowmelt floods.

IRRIGATION INVESTIGATIONS

General

All of the 11,335 acres of presently irrigated land in the watershed will be benefited by the measures proposed. There are approximately 8,040 acres of cropland, 340 acres of improved pasture, and 2,955 acres of unimproved pasture now under irrigation. This entire acreage is under the Ferron Canal and Reservoir Company.

It is anticipated that the cropland acreage will increase about 6%, the improved pasture acreage about 200%, and the unimproved pasture acreage will decrease about 76% under project conditions.

Basic Data Available

Soils

Soils in the irrigated area are divided into three treatment groups:

Group 1--Predominantly well drained, deep (usually over 60 inches), medium textured, non-saline soils with small areas of imperfectly drained, moderately saline soils due mainly to position. About 15% are moderately deep (20 inches) over gravel and cobbles. Slopes range from 0-6%. Moisture holding capacity is from 1.5 to 2.0 inches per foot of soil except 0.6 to 1.0 inches per foot in the gravelly layer. L.C.U.- IIc1, IIe20, IIe23, IIe25, IIe26, IIe27, IIw20, IIw21, IIIe23, IIIe24, IIIs27, IIIs28, and IIIe21; about 8,300 acres.

Group 2--Poorly drained, slightly to strongly saline, moderately deep, medium to fine textured soils with moisture holding capacity of 1.5 to 2.0 inches per foot. Slopes range from 0-6%. L.C.U.- IVw1, Vw1, VIs1, and VIIs1; about 3,000 acres.

Group 3--Predominantly well drained, shallow to moderately deep, fine textured soils on slopes of 0-6%. Moisture holding capacity is about 2.0 inches per foot. L.C.U.- IIIs25, IVe23, IVe24, IVe26; about 60 acres.

Climatological Data

The irrigated area ranges in elevation between 6,050 and 5,700 feet, and has a mean latitude of approximately 39° -06'N. Mean frost-free periods, (1948-1962) at Ferron, are as follows:

Threshold Temperature °F	Mean Date of Occurrence		Mean No. of Days
	Spring	Fall	
32	May 14	Oct. 19	148
28	April 26 1/	Oct. 22	177
24	April 19 1/	Oct. 30	194

1/ Interpolated from data on Emery station.

Temperature and precipitation data at the Ferron station, elevation 5,925, for the growing season are as follows:

Month	Mean Monthly Temperature (°F)	Median Monthly Precipitation (Inches)
April	47.6	0.35
May	56.0	0.54
June	66.4	0.40
July	72.5	0.54
August	69.6	1.04
September	64.3	0.78
October	50.8	0.75

Cropping Pattern

The accompanying table gives present and expected future cropping patterns for the irrigated lands in the watershed.

Crops	Present	Future W/Land Treatment Only	Future W/Land Treatment and Reservoir
Alfalfa	59	61	52
Grass Pasture (improved)	3	5	9
Grass Pasture (unimproved)	26	19	15
Small Grains and Corn Silage	12	15	24

Water Supply

Streamflow records for Ferron Creek (upper station) near Ferron, extended by correlation with Cottonwood Creek near Orangeville, are the basis for estimating the available water supply for the irrigated acreage.

Investigations

Irrigation Requirements

Monthly consumptive-use was computed by the modified Blaney-Criddle method using a local percent of daylight hours, mean monthly temperatures, a climatic coefficient, and a variable monthly crop coefficient. Since sufficient moisture to replace any soil moisture deficiency will be available from precipitation and irrigation during the non-growing season, an end-of-season soil moisture depletion of 2.0 inches was allowed in determining the net irrigation requirements. Median monthly precipitation at the Ferron station based on the 1948-1962 period and extended to a 30-year period by correlation with the Emery station record, was also deducted from the monthly consumptive-use amounts to obtain the net irrigation requirements.

The accompanying table gives the monthly net irrigation requirement in inches for the crops grown locally.

Average Monthly Net Irrigation Requirements In Inches

Crop	April	May	June	July	Aug.	Sept.	Oct.	Total
Alfalfa	0.51	3.39	5.76	7.12	5.29	2.54	0.00*	24.61*
Grass Pasture	1.29	2.73	4.69	5.83	4.35	1.93	0.00*	20.82*
Small Grain	0.09	1.86	8.17	3.85	0.00*	----	-----	13.97*
Corn Silage	----	0.44	3.27	8.41	4.01	0.00*	-----	16.13*

* Soil moisture depletion of 2.0 inches deducted at end of season.

Contributions to consumptive-use from the water table is considered negligible on areas other than unimproved pasture. It was assumed that no irrigation water was applied to unimproved pasture during July, August, and September.

Irrigation Supply

The monthly and seasonal water supply from Ferron Creek was determined from the U. S. Geological Survey streamflow records. The Ferron Creek values were extended by correlation with Cottonwood Creek near Orangeville to give a 30-year period of record (1933-1963) which is the basis for present water supply. A reservoir operations study on the Mill Site Reservoir using this 30-year record is the basis for future water supply.

The present and future median monthly diversion supply is estimated in the following table:

Median Diversion Supply 1/

Month	Present 2/	Future 3/
April	0.23	0.12
May	1.23	0.54
June	1.21	1.12
July	0.35	1.13
August	0.21	0.42
September	0.12	0.10
Total	3.35	3.43

1/ One-half of the time, for example 14 years out of 28, the irrigation supply at the diversion for the months shown above has been equal to or greater than the amount shown. During the remainder of the time, the diversion supply has been less than this. (Units are in acre feet per acre.)

2/ Natural streamflow.

3/ Reflects storage regulation.

Irrigation Efficiencies

Estimates of present on-farm irrigation efficiencies were determined by the experience and judgment of the local Soil Conservation Service technicians and from efficiency checks in this and other areas having similar soils, slopes, and irrigation methods and management. Improvement in the average level of efficiencies are expected to be accomplished by the on-farm land treatment program to be installed by the additional technical and educational assistance to be made available and by the improved irrigation supply resulting from the irrigation system improvement measures, and the Mill Site Reservoir.

The following ranges in on-farm irrigation efficiencies were estimated and used in the analysis:

Project Increment	Efficiency (%)
Present (non-project)	33
Future (10 years, with project)	46

The principal methods of irrigation are the use of corrugations and wild flooding. Wild flooding is practiced mainly on alfalfa and grass pasture.

Conveyance and Operational Losses

Inflow-outflow measurements on the majority of the main canals and laterals during the 1962 and 1963 irrigation seasons supplemented by several measurements with the "Falling Head Seepage Meter" indicate that the present over-all conveyance and operational losses are in the magnitude of 15 percent of the diverted flows.

With the proposed improvements to the irrigation system including canal and lateral lining, new diversions, water control structures, and measuring devices, it is expected that future over-all conveyance and operational losses will be reduced to a magnitude of about 8 percent of the diverted flows.

System Capacity Requirements

Delivery of water to the individual water users will be changed from the existing continuous flow system to a modified demand system.

Design capacities of the canal lining will be in accordance with the optimum standard of having capacity sufficient to meet peak period irrigation requirements. Peak period irrigation requirements were based on the weighted peak period consumptive use. Rates range from 0.26 on the deeper valley soils to 0.27 on the shallower benchland soils. These rates, when adjusted for the on-farm and conveyance efficiencies were the basis for determining the minimum design capacity of the canal lining.

ECONOMICS

Initial examination of the watershed with sponsor groups and the Service gave an over-all picture of watershed problems. Further examination with the planning technicians provided material for a preliminary feasibility report and a work outline. A study outline was made up to define major study items and to establish survey and fact collecting procedures.

Evaluation units were determined jointly by the hydrologist, sedimentationist, engineer, and economist. They included:

1. Twelve flood damage evaluation units

2. One irrigation evaluation unit

The flood damage evaluation units were single drainages debouching onto separate flood damage areas. The irrigation evaluation unit was the total service area of the Ferron Canal and Reservoir Company, which is the only irrigation company in the watershed.

For purposes of economic evaluation and project formulation, the economic studies included:

1. Basic Economic Data. The economy of the watershed is dominated by livestock agriculture with non-farm employment in coal mining occupying a secondary but important position. Basic information was collected on livestock and crop production, crop yields, size distribution of farming units, farming, livestock and irrigation practices, type of farming enterprises, non-agricultural employment, and other general economic information. This information was secured from ranch operators in the watershed, from census reports, the Emery County ASC office, irrigation company records, records of other federal and state agencies, University reports, and other secondary sources.

2. Flood Damage Investigations

   a. Damage investigations included determination of the nature and distribution of croplands, structures, improvements, and facilities subject to damage by flood runoff in each flood evaluation unit. All areas and structures, including farm and commercial buildings and residences, were located and considered in reference to their susceptibility to damage by flood flows from each flood source area.

   b. Interviews were carried out with individuals to obtain information on (1) frequency of flood occurrences, (2) areas of flood damage, (3) kind and amount of damage, (4) estimates of relative flood size, and (5) flood sources. In all, interviews concerning flood occurrences and damage were had with 34 individuals. In addition, flood reports by Soil Conservation Service personnel and other reports were studied and pertinent information used.

   c. During the period of study, the summer months of 1963 and 1964, small floods affecting most of the evaluation units were observed. Resultant damages formed the basis of special damage appraisals and flood reports. Since such small floods are typical of floods which occur on an average of every year in this area, these occurrences furnished valuable first-hand information on agricultural and other damages. Cross sections of flows in the flood channels were taken, the flows were correlated with the observed damages and utilized as part of the basic data in the flood series analysis. As stated, floods from most of the drainages of each evaluation unit are a yearly occurrence and some type of damage results with each occurrence. Since they were small and frequent, recent historical occurrences were considered representative of floods ranging from the annual to the 5-year frequency. The selection of this frequency range was further substantiated by farmer experience in the damage area.

   d. The information gathered through surveys, interviews and examination of the flood damage areas formed the basis for establishing an annual damage base for each evaluation unit. In general, most of the item-by-item flood damage estimates were developed by projecting inventoried damages from floods reported by ranchers or others. Frequencies of damage occurrence by item were determined by farmer estimates and by observation of the damage items in reference to their position in the

damage area. Discharge-frequency flood series developed by the hydrologist were used in projecting the inventoried damages to reflect item damages for larger or smaller floods in the series. The annual damage base for each item was converted to long-term prices and costs, using conversion factors reflecting the item(s) involved. The total annual damage base for each evaluation unit was the sum of the individual damage items.

e. Of the twelve damage evaluation units studied, nine units were found to have annual damages of a magnitude such as to constitute a significant flood problem. The itemized estimates of the damage bases, residual damages, reductions from land treatment (where installed) and water conservation benefits are shown in the table which follows.

FERRON WATERSHED

Damage Base - Damage Reductions

Benefits

Evaluation Unit	Annual Damage Base - Dollars										Damage Reduction Benefit	Reduction due to Land Treatment	Reduction by Structure	Water Conservation Benefit	Total Structure Benefit
	Structures Farm & Home	Road and Bridge Damage	Food Materials Cleanup	Canals - Irrigation Facilities	Crop and Pasture	Land and Production Damage	Irrigation Interruption	Indirect Damage	Total Annual Damage	Residual Damage					
North Ditch															
Diversion Hollow		305	255	400	415		740	210	2,325	105	2,220		2,220	240	2,460
Indian Hollow	230	490	420	685	690		740	330	3,585	165	3,420	655	2,765	300	3,065
Eli Hollow		620	150	545	1,365	380		305	3,365	175	3,190	350	2,840	370	3,210
Jewkes Hollow		180	135	595	815	740		245	2,710	190	2,520	225	2,295	335	2,630
Subtotal North Ditch	230	1,595	960	2,225	3,285	1,120	1,480	1,090	11,985	635	11,350	1,230	10,120	1,245	11,365
South Ditch															
Zwahlen Wash		490	360	695	1,995	1,090	940	465	6,035	225	5,810	745	5,065	1,160	6,225
Straight Hollow (N)			165	930	1,655	115		285	3,150	195	2,955	220	2,735	110	2,845
Straight Hollow (S)		575	425	1,355	2,985	1,685		700	7,725	960	6,765	345	6,420	590	7,010
Dutch Flat		85	50	430	1,100	2,140		380	4,185	655	3,530	150	3,380	335	3,715
Subtotal South Ditch		1,150	1,000	3,410	7,735	5,030	940	1,830	21,095	2,035	19,060	1,460	17,600	2,195	19,795
Ferron Creek (Mill Site Reservoir)	2,010	835	5,885	3,355	2,035	4,280	3,200	1,410	23,010	1,275	21,735	2,675	19,060		19,060
TOTALS	2,240	3,580	7,845	8,990	13,055	10,430	5,620	4,330	56,090	3,945	52,145	5,365	46,780	3,440	52,220

f. The estimates shown for Ferron Creek (Mill Site Reservoir) are based on a 70% sample of all lands lying along the creek in the reach below the Mill Site Reservoir. Item damages recorded were discriminately projected to reflect damages to the entire reaches in accordance with the amount and distribution of the item involved in the uninventoried part of the reach.

The evaluation of the damage base for Ferron Creek also includes the item of widespread distribution of damaging sediment throughout the irrigated area which originates from the Ferron Creek drainage and is distributed through canals and ditches and onto the land. This type of damage is independent of the sediment deposited on irrigated lands by floods from the small drainages which make up the other evaluation units. Furthermore, the sediment from Ferron Creek is distributed over a wider area. These estimates were developed through information obtained from sedimentation studies.

g. Residual damages are largely based on estimates of suspended sediment which will be discharged through the spillways of the structures and from runoff from small uncontrolled areas.

h. Water conservation benefits assigned to the debris basins originate from the impoundment of the flood flows in the structures and their slow release into the canals. With no control, as at present, no beneficial use is made of the water. Average annual volumes were calculated from the flood series developed by the hydrologist for each evaluation unit. Unit values of $15 per acre foot were used to obtain total water conservation benefits.

i. Damage reductions from upper watershed land treatment were based on the full reductions in flood runoff expected from the improvement in vegetative conditions, discounted for a 50-year lag in full accrual.

Irrigation Analysis

Information on average crop yields, irrigation practices and per acre yields of crops at various levels of water supply was secured on 17 farms in the watershed. These surveys covered the principal crops--alfalfa, small grain, corn silage, and irrigated pasture. Average full supply yields were established for each crop. Because the 17 farm samples had been stratified and weighted among the not too variable soil groups, average full supply yields reflected production throughout the irrigation evaluation unit. Yields under future conditions without the project and with the project were projected from present yields and reflect the beneficial influence of the land treatment, reservoir and lining on water supply, improved crop rotation, fertilizer use and other improved practices. The table on the following page outlines full supply yields used in the analysis.

Table 1. Crop Yields - Various Project Conditions

Condition	Crops--Full Supply Yields/Acre Alfalfa (tons)	Barley (Bu.)	Corn Silage (tons)	Irrigated Pasture (AUM's)
Present	3.5	51	13	5
Future w/going land treatment program	3.7	53	14	6
Future w/all land treatment	3.7	53	14	7
With land treatment, reservoir, and lining	4.0	59	16	8

A 30-year record of the streamflow gave a basis for determining the present median semi-monthly water supply. The benefits from the going and accelerated land treatment program were measured as improvements in irrigation efficiency. It was estimated that the diversion point over-all efficiency would move from 28% to 31% with the going land treatment program and that the accelerated land treatment program would raise diversion point efficiencies to 39%. It was taken that the lining would raise over-all diversion efficiency to 42%.

Analysis was made of each level of efficiency or water supply and the total yields of each crop calculated. These yields are shown below.

Table 2. Average Yields Under Various Project Conditions

Condition	Alfalfa (tons)	Small Grain (Bu.)	Corn Silage (tons)	Irrigated Pasture (AUM's)
Present	1.60	51	13	1.22
Future w/going land treatment	1.67	55	14	2.00
Future w/all land treatment	1.84	57	14	2.21
With land treatment, reservoir, and lining	3.48	59	16	3.76

A ranch survey was also conducted on 14 of the sample farms. This included 11 beef ranches and 3 dairy farms. Information gathered in this study included data on numbers and age classes of livestock, marketing practices, feeding and grazing schedules, dry feed rates, source of grazing by private range, National Forest and National Reserve and other pertinent information. This information was tabulated and organized and was used in conjunction with the crop production information and crop budgets to make up ranch budgets reflecting present conditions, future conditions without a project, and future conditions with a project. The significant elements of this analysis are shown below:

Table 3. Crop and Livestock Production - Three Conditions

	Present	Future W/O Project	Future With Project
Irrigated Acres Model Ranch	88	99	110
Crop Production			
Alfalfa (tons)	10,715	11,555	20,095
Small Grain (bushel)	46,380	60,090	103,175
Corn Silage (tons)	5,850	7,924	15,536
Irrigated Pasture (aum)	4,034	5,555	10,161
Aftermath-Public and Private Grazing	19,150	15,470 1/	21,525
Total AUM's	58,635	54,565	95,605
Animal Units Per Ranch			
Beef	43	52	106
No. Ranches	111	87	75
Dairy	21	28	53
No. Ranches	12	27	27

1/ Reflects adjustments in public grazing permits.

This analysis points up the impact of decreasing grazing resources and the limited potential for improvement under going (future without project) programs.

Using the levels of crop production for the three analysis conditions and the various kinds of feed resources available for the model ranch typical of each condition, ranch budgets were formulated. These included both beef and dairy budgets. On the cost side, the budgets included all out-of-pocket costs plus interest charges on land, buildings, and livestock. Livestock and livestock products sold were valued at long-term prices adjusted to local levels.

Aggregate gross benefits to project effects were calculated as differences between total ranch returns at the going program level and the total net returns with all project measures installed. These were reduced to net project benefits reflecting project effects as shown below.

Summary - Project Benefits

	Non-Project	Project
Net Returns - Beef Enterprise	$ 57,420	$303,750
Net Returns - Dairy Enterprises	82,350	201,690
Total Net Returns - Livestock	$139,770	$505,440
Average Net Return Per Farm	1,225	4,955
	(114)	(102)
Gross Project Benefits Based on Livestock	---	$365,670
Less Annual Associated Land Treatment Cost (Accelerated Land Treatment)		7,780
Primary Benefits Residual to Labor and Project Effects		$357,890

Adjusted Irrigation Benefits

Under the livestock budget method of analysis, the net ranch income is a residual to labor and management. In calculating benefits via the difference between the project and non-project conditions, the increased labor inputs required to achieve the increased production are included in primary benefits. If increased labor inputs are to be defined as redevelopment benefits, they must be separated from the primary irrigation benefits and they (the primary benefits) must be adjusted to a net value.

Adjustment:

Total Primary Benefits	$357,890
Annual Adjusted Value-Increased Labor Inputs	30,510
Total Net Adjusted Primary Irrigation Benefits	$327,380

Redevelopment Benefits

Although redevelopment benefits were not used for project justification, they were defined and calculated so as to give a better perspective of the project impact. Calculated redevelopment benefits arising from increased farm labor inputs associated with increased project production were used to reduce primary irrigation benefits to a net annual value as previously shown. Other redevelopment benefits were associated with construction of structures, land treatment,

and recreation. The installation period costs assignable to local labor were reduced to annual costs limited to 20 years, and distributed over a 100-year period, in accordance with prescribed procedure. The summary of these benefits is shown below.

Summary

Construction	$16,745
Land Treatment	5,585
Increased Labor Inputs	30,510
Recreation	1,425
Total Redevelopment Benefits	$54,265
Less 10% increased labor inputs counted as secondary benefits	$ 3,050
Net Adjusted Total Redevelopment Benefits	$51,215

Secondary Benefits

Secondary benefits were based on (1) 10% of the net flood prevention benefits after land damage and indirect benefits were deducted from the total, (2) 10% of net primary irrigation benefits, and (3) 10% of the increased production costs required to produce the primary irrigation benefits. The manner in which the estimates were made are shown below.

Flood Prevention 1/

	Total Benefits	Benefits Excluding Land Damages and Indirect	Benefits "Stemming From" (10%)
Mill Site Reservoir	21,735	16,365	1,635
Debris Basins			
North	11,350	9,510	950
South	19,060	13,760	1,375
			3,960

1/ No "induced by" calculated because flood damage requires purchase of materials and services which cancel out loss of trade involving production losses.

"Induced by" Secondary Benefits

Production Costs - Livestock Basis

	Without Project	With Project
Beef		
Cost Base for "Induced" Benefits (per unit)	$ 2,955	$ 4,060
Number of Beef Units	87	75
Total Beef Production Costs	$257,085	$304,500
Dairy		
Cost Base for "Induced" Benefits (per unit)	$ 6,465	$ 10,900
Number of Dairy Units	27	27
Total Dairy Production Costs	$174,555	$294,300
Total All Livestock Costs	$431,640	$598,800
Secondary Benefits @ 10%	$ 43,165	$ 59,880
Induced Secondary Benefits Produced by Project	$ 16,715	

Irrigation Measures

	Primary Benefits	"Stemming From"	Induced
Mill Site Reservoir	272,705	27,270	13,925
System Improvement	54,675	5,465	2,790
	327,380	32,735	16,715

Summary

	Stemming	Induced	Total
Mill Site Reservoir:			
Flood Prevention	$ 1,635	------	$ 1,635
Irrigation	$27,270	$13,925	41,195
System Improvements:	5,465	2,790	8,255
Total Secondary Irrigation Benefits	$34,370	$16,715	$51,085
From Flood Prevention Structures			2,325
Grand Total			$53,410

Fish and Wildlife and Recreation Benefits

The evaluation of recreation benefits is based on (1) delineation of the primary demand area, (2) projection from the present population of the primary demand area to a population for 1980, (3) an estimate of tourist and non-local travel through the watershed and the proportion of such travel which would use project facilities, (4) the participation rates of the primary demand area population for the types of recreation afforded by the project, (5) the peak and average capacity of the facilities, and (6) adjustment of estimated "activity" days of use to "visitor" days by applying a factor of .70 to the number of activity days. Unit values per visitor day ranged from $.50 to $1.50 in accordance with the criteria set forth in Supplement No. 1, Evaluation Standards for Primary Outdoor Recreation Benefits. The estimated demands, capacities, visitor days, and benefits are shown below.

Water resource improvements for fish and wildlife in the upper watershed have been evaluated. Estimates made by Utah State Department of Fish and Game specialists indicate the average level of fishing use will be 18,700 angler days per year. Converted to monetary benefits @ $1.50 per angler day, this would give benefits of $28,050 per year.

Use Adjusted from Activity Days to Visitor Days 1/

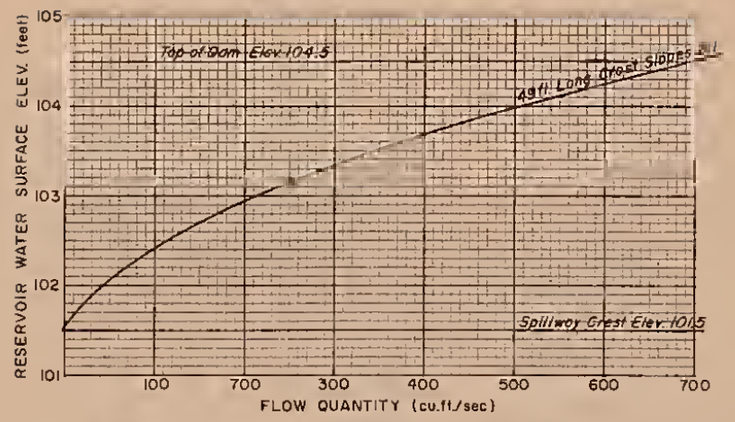
Activity	Activity Days	Adjustment Factor	Visitor Days
Picnicking	18,145	.70	12,700
Overnight Camping	2,270	.70	1,590
Boating	5,865	.70	4,105
Fishing	19,800	.70	13,860

1/ Use adjusted to reflect participation in more than one activity per visit.

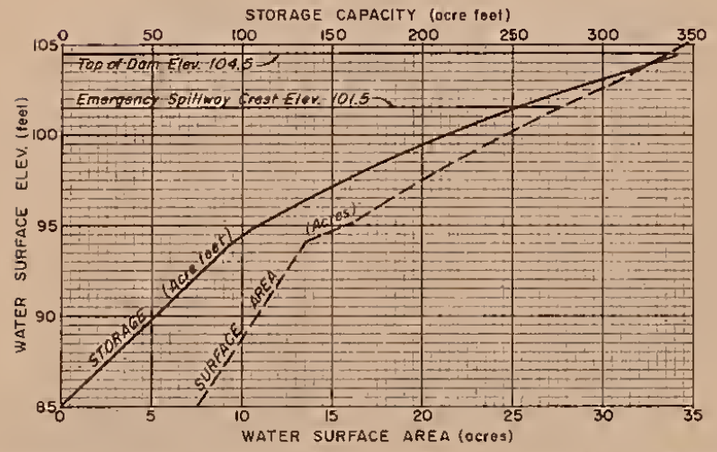
Benefits - Recreation Facilities and Reservoir

	Picnicking			Overnight Camping			Boating			Fishing		
	Unit Value	Visitor Days	Total Value	Unit Value	Visitor Days	Total Value	Unit Value	Visitor Days	Total Value	Unit Value	Visitor Days	Total Value
	$		$	$		$	$		$	$		$
Without Project	.50	100	50	.50	180	90	--	--	--	1.00	500	500
Reservoir and Basic Facilities	1.50	12,700	19,050	1.50	1,590	2,385	1.50	4,105	6,160	1.50	13,860	20,700
Benefits												
Reservoir and Basic Facilities			19,000			2,295			6,160			20,200

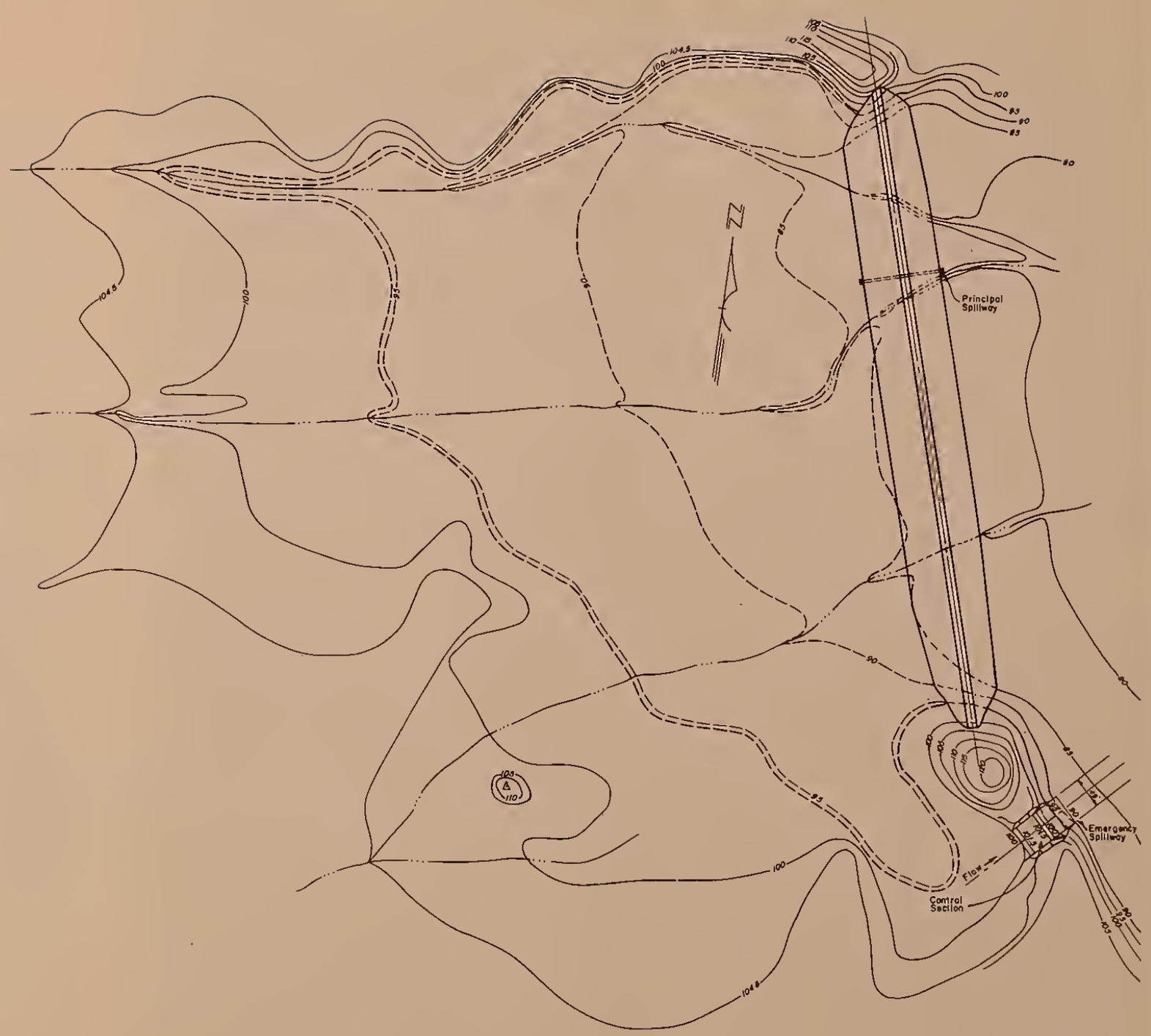
Total Benefits $47,745

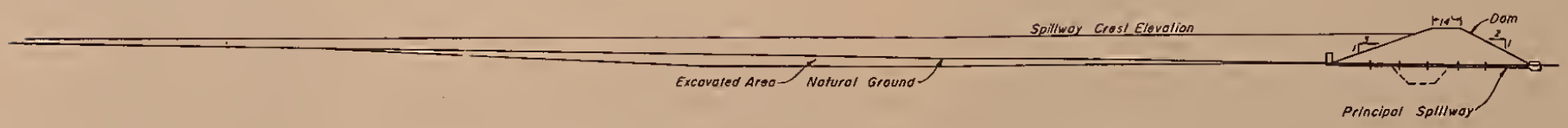


EMERGENCY SPILLWAY DISCHARGE CURVE



RESERVOIR SURFACE AREA-CAPACITY CURVES





AVERAGE CROSS SECTION OF DAM & RESERVOIR AREA

40 0 40 80
SCALE IN FEET

FIGURE 2
WORK PLAN

TYPICAL DEBRIS BASIN

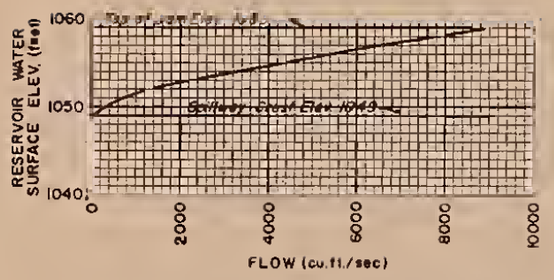
STRAIGHT HOLLOW (South)
FERRON WATERSHED

SAN RAFAEL S.C.D., EMERY & SANPETE COUNTIES, UTAH

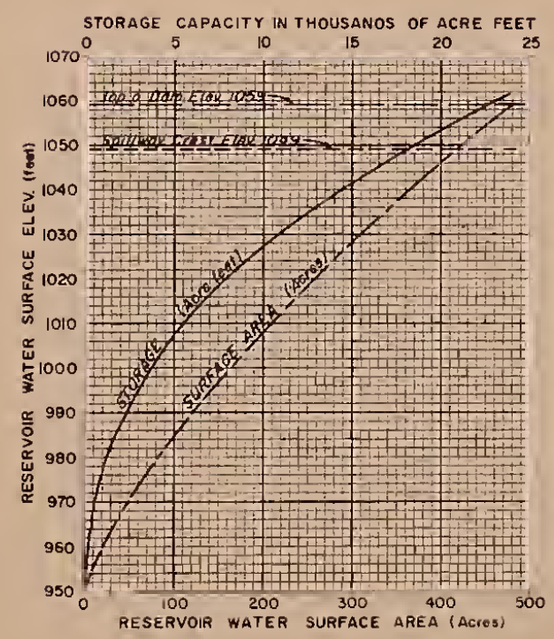
PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by _____ Date 8/64 Orwg No 7-E-17782-N
Sheet of Sheets



SPILLWAY DISCHARGE CURVE



AREA - CAPACITY CURVES

PLAN

FIGURE 3

WORK PLAN

MILLSITE RESERVOIR DAM

FERRON WATERSHED

SAN RAFAEL S.C.D., EMERY & SANPETE COUNTIES, UTAH

PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

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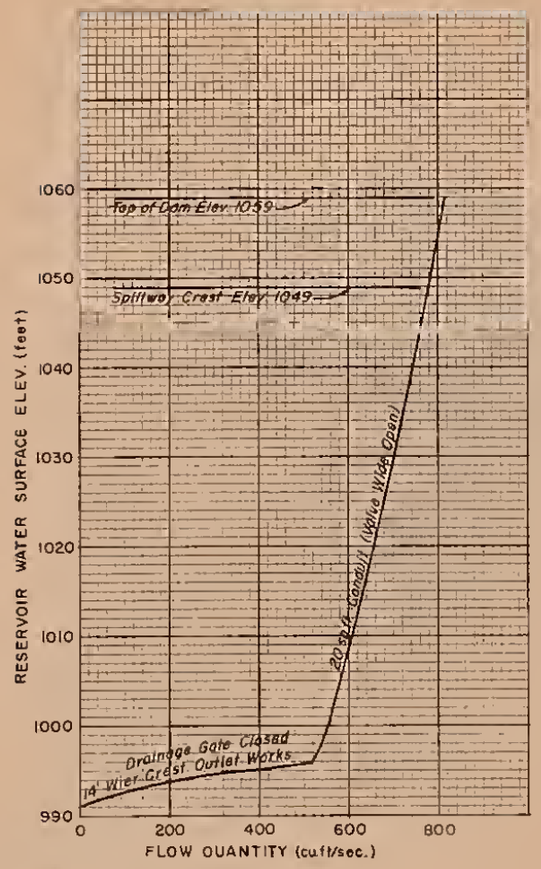
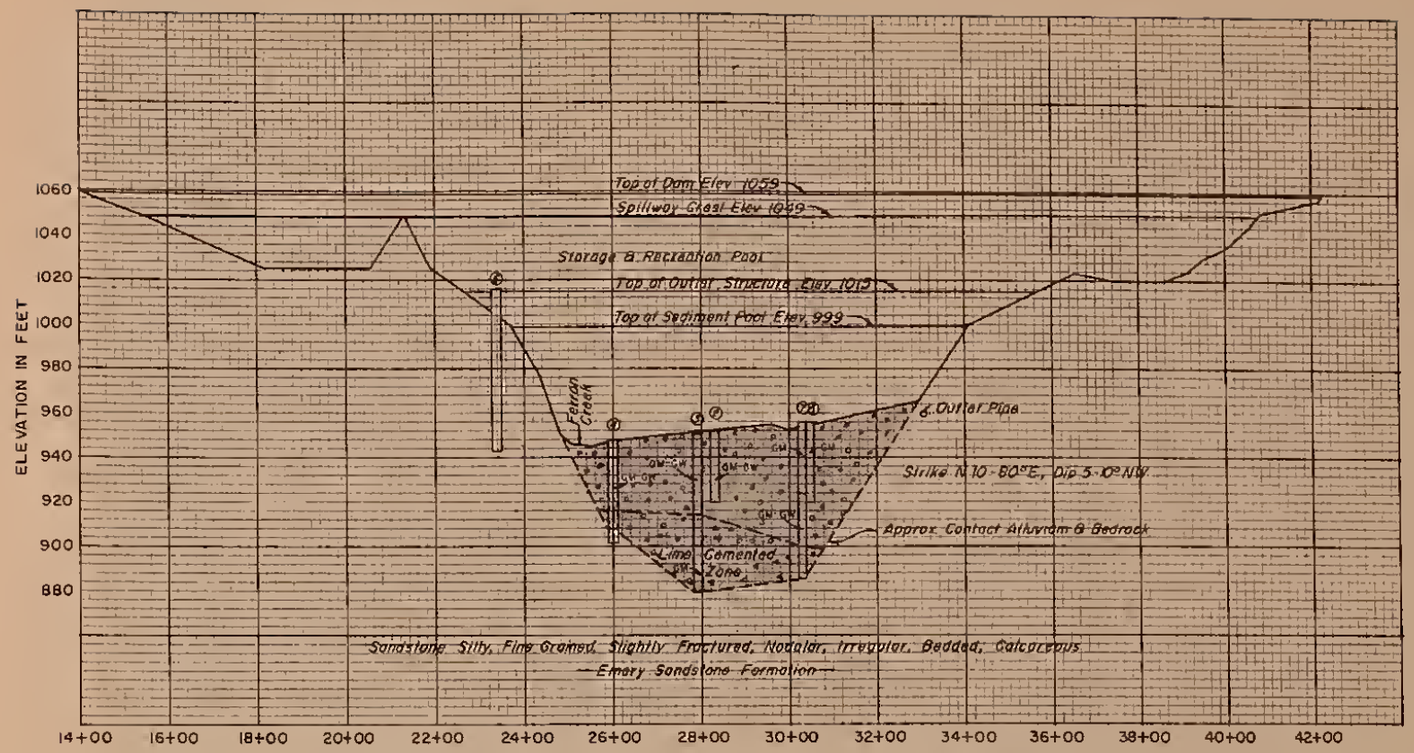


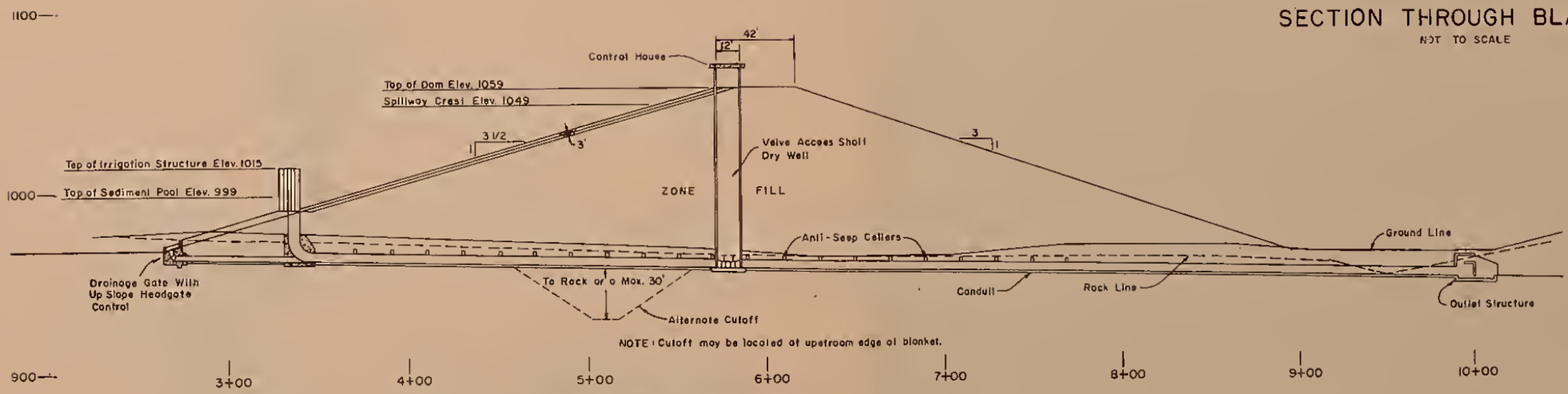
OUTLET DISCHARGE CURVE



PROFILE & GEOLOGIC SECTION - ℄ OF DAM

SECTION THROUGH BLANKET

NOT TO SCALE



SECTION THROUGH OUTLET WORKS

FIGURE 4

WORK PLAN

MILLSITE RESERVOIR DAM

FERRON WATERSHED

SAN RAFAEL S.C.D., EMERY & SANPETE COUNTIES, UTAH

PRELIMINARY PLANS

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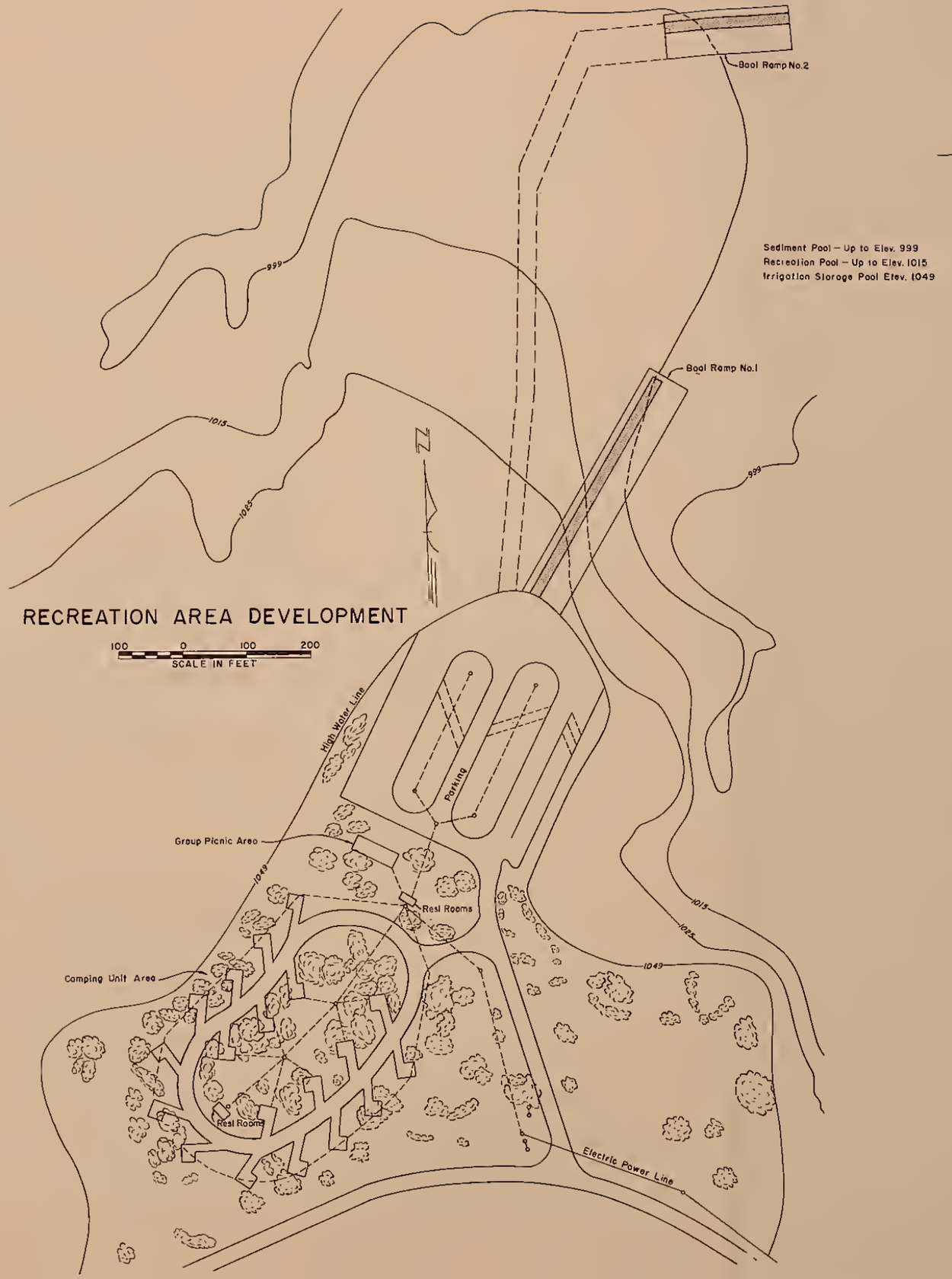
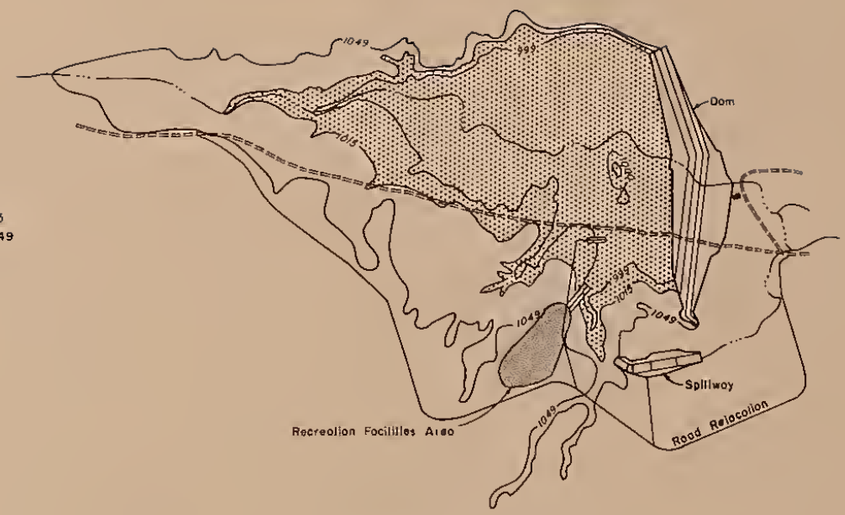
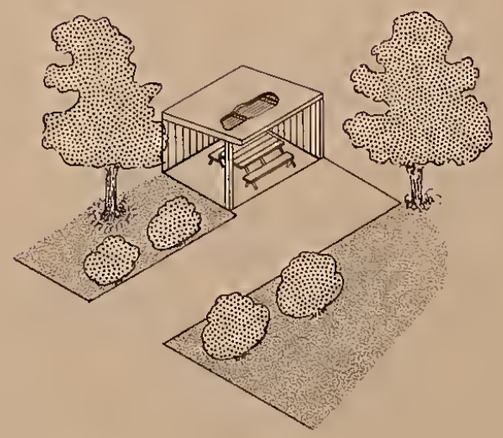


RECREATION AREA DEVELOPMENT



LOCATION SKETCH



CAMPING UNIT DETAIL

FIGURE 5
WORK PLAN

MILLSITE RESERVOIR DAM SITE

RECREATION DEVELOPMENT PLAN

FERRON WATERSHED

SAN RAFAEL S.C.D., EMERY & SANPETE COUNTIES, UTAH

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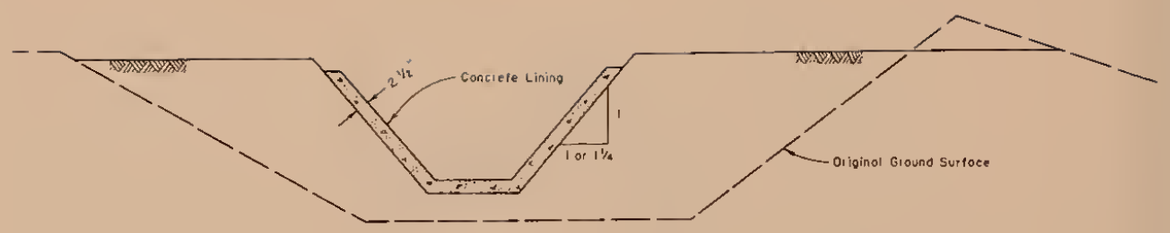
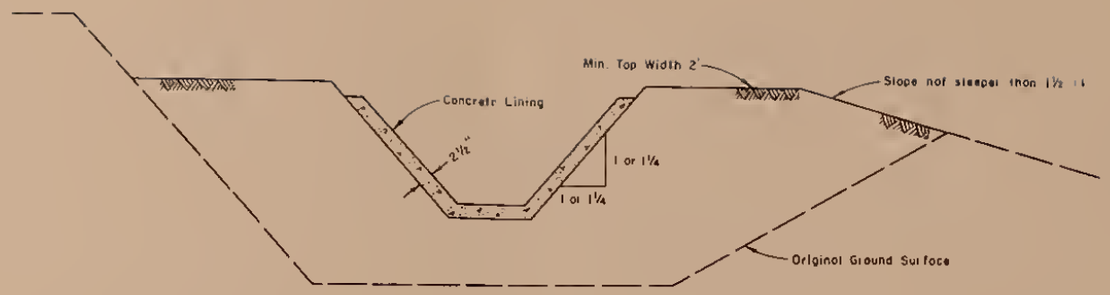
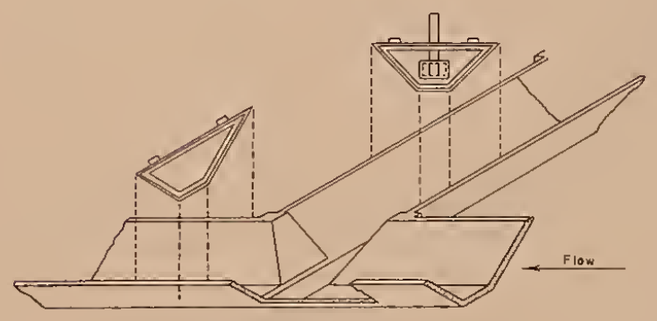
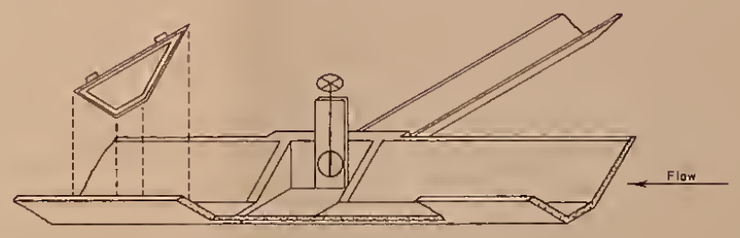




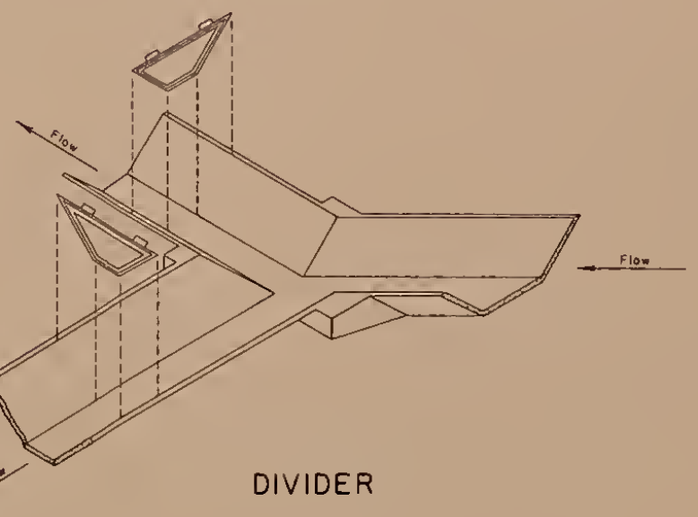
TYPICAL CANAL SECTION



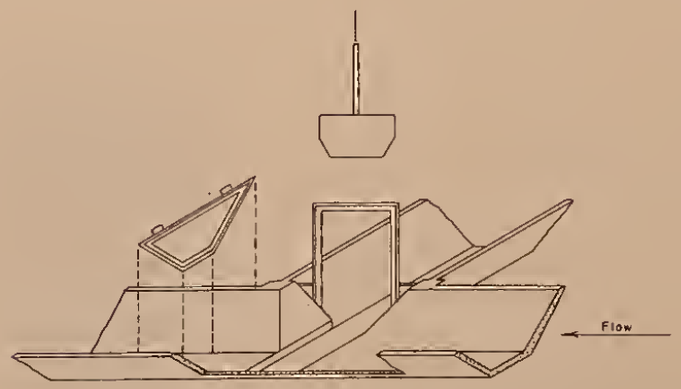
TRAPEZODAL CHECK GATE



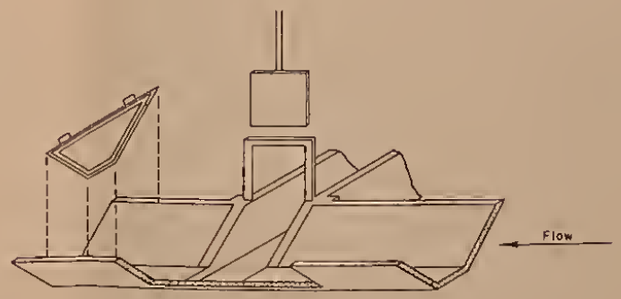
ROUND CAST IRON SCREW GATE



DIVIDER



TRAPEZODAL SLIDE GATE



RECTANGULAR SLIDE GATE

TYPICAL TURNOUT STRUCTURES

FIGURE 6
WORK PLAN
CANAL LINING
FERRON WATERSHED
SAN RAFAEL S.C.D., EMERY & SANPETE COUNTIES, UTAH
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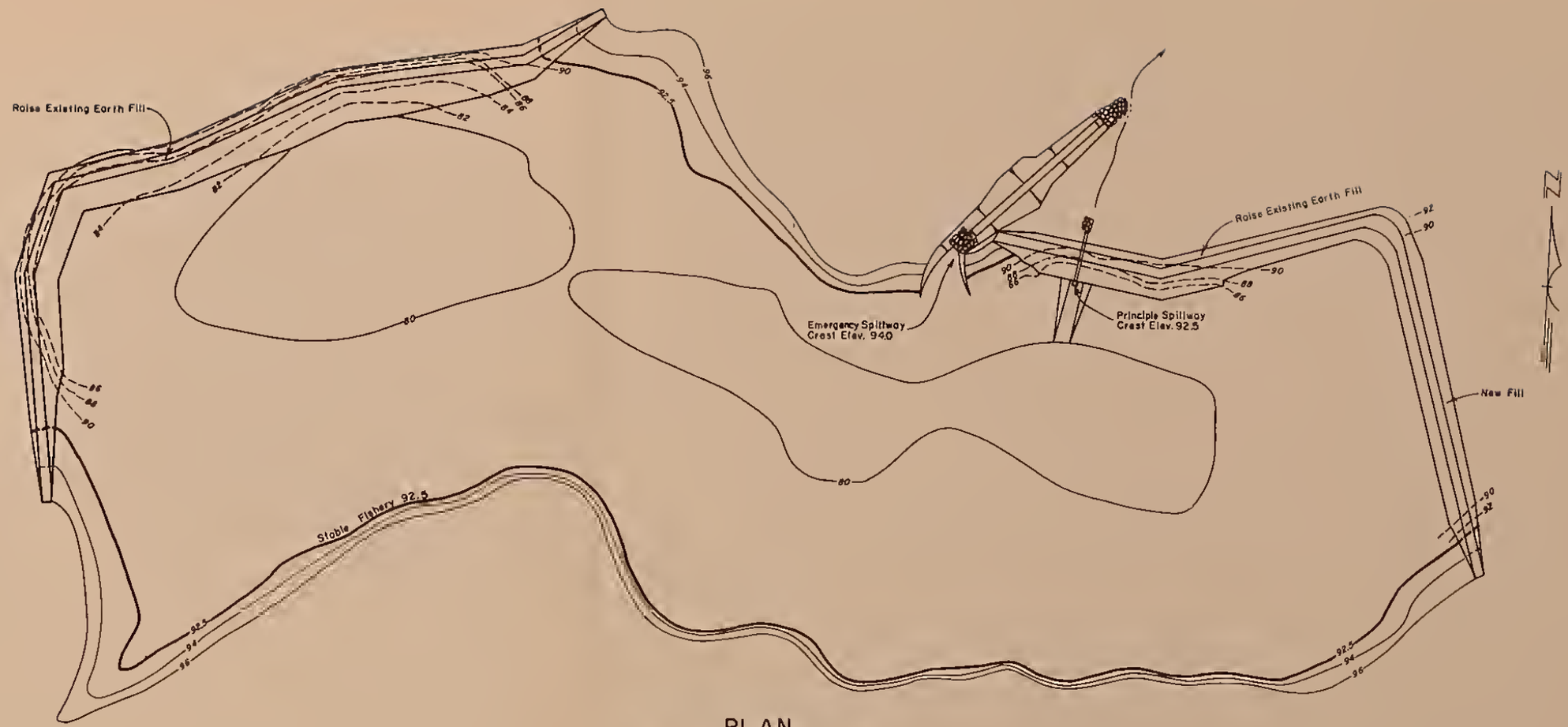
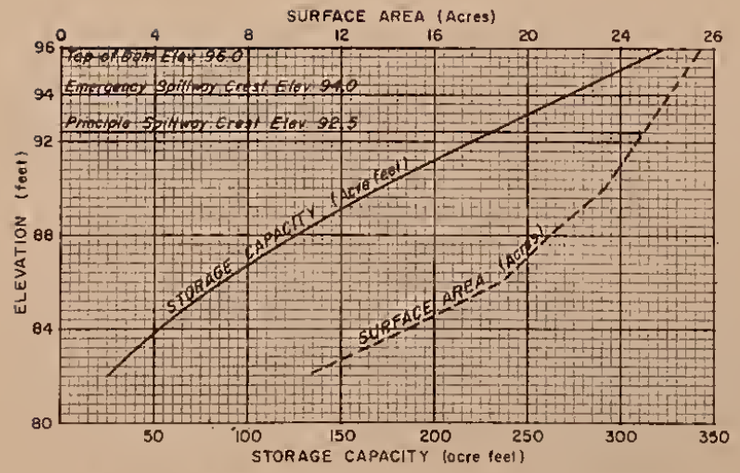
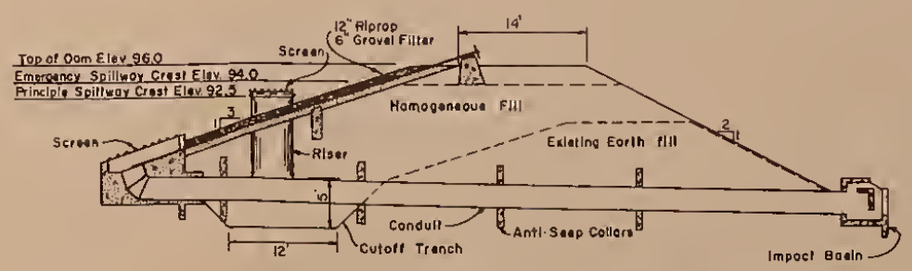


PLAN

100 0 100 200
SCALE IN FEET



RESERVOIR AREA - CAPACITY CURVES



X-SECTION SPILLWAYS & EMBANKMENT
NOT TO SCALE

FIGURE 7
WORK PLAN

WILLOW LAKES FISHERY

FERRON WATERSHED

SAN RAFAEL S.C.D., EMERY & SANPETE COUNTIES, UTAH

PRELIMINARY PLANS

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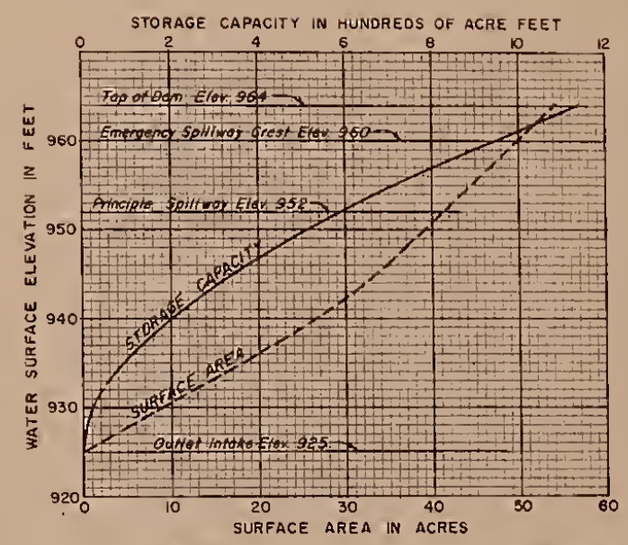
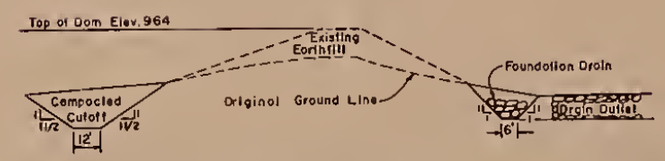
PLAN

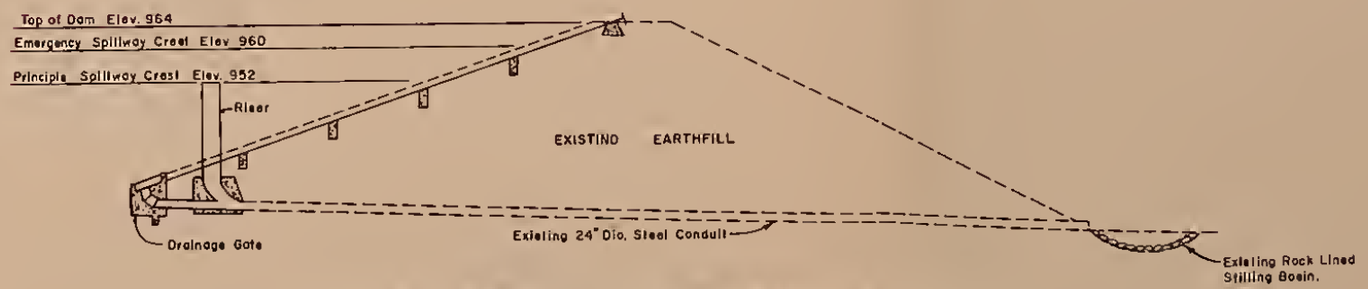
150 0 150 300
SCALE IN FEET



RESERVOIR AREA-CAPACITY CURVES



CROSS-SECTION SHOWING CUTOFF & ROCK DRAIN
NOT TO SCALE



CROSS-SECTION SHOWING RISER & DRAINAGE GATE
NOT TO SCALE

FIGURE 8
WORK PLAN

DUCK FORK FISHERY
FERRON WATERSHED

SAN RAFAEL S.C.D., EMERY & SANPETE COUNTIES, UTAH
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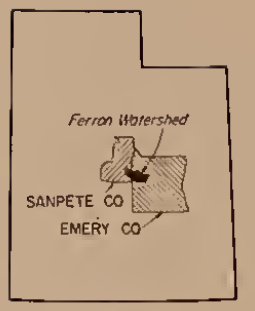

LOCATION MAP

L E G E N D

- Multiple Purpose Structure (S – Sediment Pool; R – Recreation Pool; I – Irrigation Pool)
- Canal Lining
- Diversion Dam
- Debris Basin
- Proposed Access Roads & Road Relocation
- Stabilization of Critical Areas
- Area Benefited
- Drainage Area Controlled by Structures
- Water Resource Improvement for Fish & Wildlife
- Gully Plug
- Large Gully Plug
- Forest Boundary

N

FIGURE 1

PROJECT MAP

FERRON WATERSHED

EMERY & SANPETE COUNTIES, UTAH

AUGUST 1964

SCALE IN MILES 0 1 2 3 4

7-S-17474-N

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